INDEX NUMBER

ANNUAL SUBSCRIPTION: UNITED STATES AND CANADA, $10.00; FOREIGN, $12.00 (£2 10s.)

Volume XXIV JUN 6 1917 JUNE, 1917 Number 6

UNIV. OF MICH. LIBRARY

Surgery, Gynecology and Obstetrics

WITH

International Abstract of Surgery

EDITORIAL STAFF

FOR AMERICA

William J. Mayo, M.D.

E. Wyllys Andrews, M.D. J. Clarence Webster, M.D.

L. L. McArthur, M.D. E. C. Dudley, M.D. Frederic A. Besley, M.D.

A. J. Ochsner, M.D. C. S. Bacon, M.D. Carl Beck, M.D.

Thomas J. Watkins, M.D. John L. Porter, M.D. William R. Cubbins, M.D.

FOR THE BRITISH EMPIRE

A. W. Mayo-Robson, C.V.O., D.Sc., F.R.C.S.

Sir Berkeley Moynihan, M.S., F.R.C.S. Thomas W. Eden, M.D., F.R.C.S.

Harold J. Stiles, M.B., F.R.C.S. (Edin.) Henry Jellett, M.D., F.R.C.P.I.

James Rutherford Morison, M.B., F.R.C.S.

Franklin H. Martin, M.D., Managing Editor

Allen B. Kanavel, M.D., Associate Editor

EDITORIAL AND BUSINESS OFFICES: 30 N. Michigan Ave., Chicago, Illinois, U. S. A.

PUBLISHERS FOR GREAT BRITAIN: Bailliere, Tindall & Cox, 8 Henrietta St., Covent Garden, London, W. C., England

Five Important Books

published by

W. B. Saunders Company

See Page 13

Entered as second-class matter May 22, 1913, at the postoffice at Chicago, Ill., under the Act of Congress, March 3, 1897.

Copyright, 1917, by The Surgical Publishing Company of Chicago.

X-Ray Economies

Here's a way to follow your patriotic impulse to economize—as the President asks—and do it with even *better* results than the more expensive way has been giving you.

PARAGON X-RAY PLATES

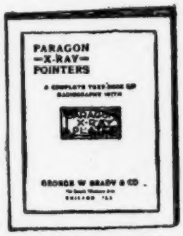
Use Soft Tube Technique

No matter what type or make of X-Ray apparatus you use, Paragon Milli-Amp-Second Technique will give you the maximum of results for the minimum of expense and work. It eliminates guessing—saves tubes—plates—time.

Paragon X-Ray Plates are famous for their uniformity, speed, sharp contrasts, delicate shadings, black backgrounds. If you don't know them, ask for our dollar demonstration offer.

Universal X-Ray Plates are lower in price, but of high quality. Work fast with or without screen. Fine on extremities, for serial work, charity cases, etc.

Geo. W. Brady & Co. 756 S. WESTERN AVENUE **Chicago**



Every Roentgenologist needs this treatise on X-Ray Technique.

New Edition

Revised—latest data on X-Ray procedure. Ready soon. Send your name. Get a copy free, soon as published.

Information Bureau

We manitain the *only* Bureau of Information on X-Ray subjects. New men in the work—or older ones who strike knotty problems—write us. State make and type of machine. Our practical help free to users of Paragon or Universal Plates.

Many Brilliant Operations Have Been Marred by Sepsis

A focal infection removed from the seat of operation may be pouring bacteria into the blood stream, ready to lodge at a point of lowered resistance such as a laceration, an incision, a suture, a blood clot, and there set up an infection in spite of all technical and aseptic care.

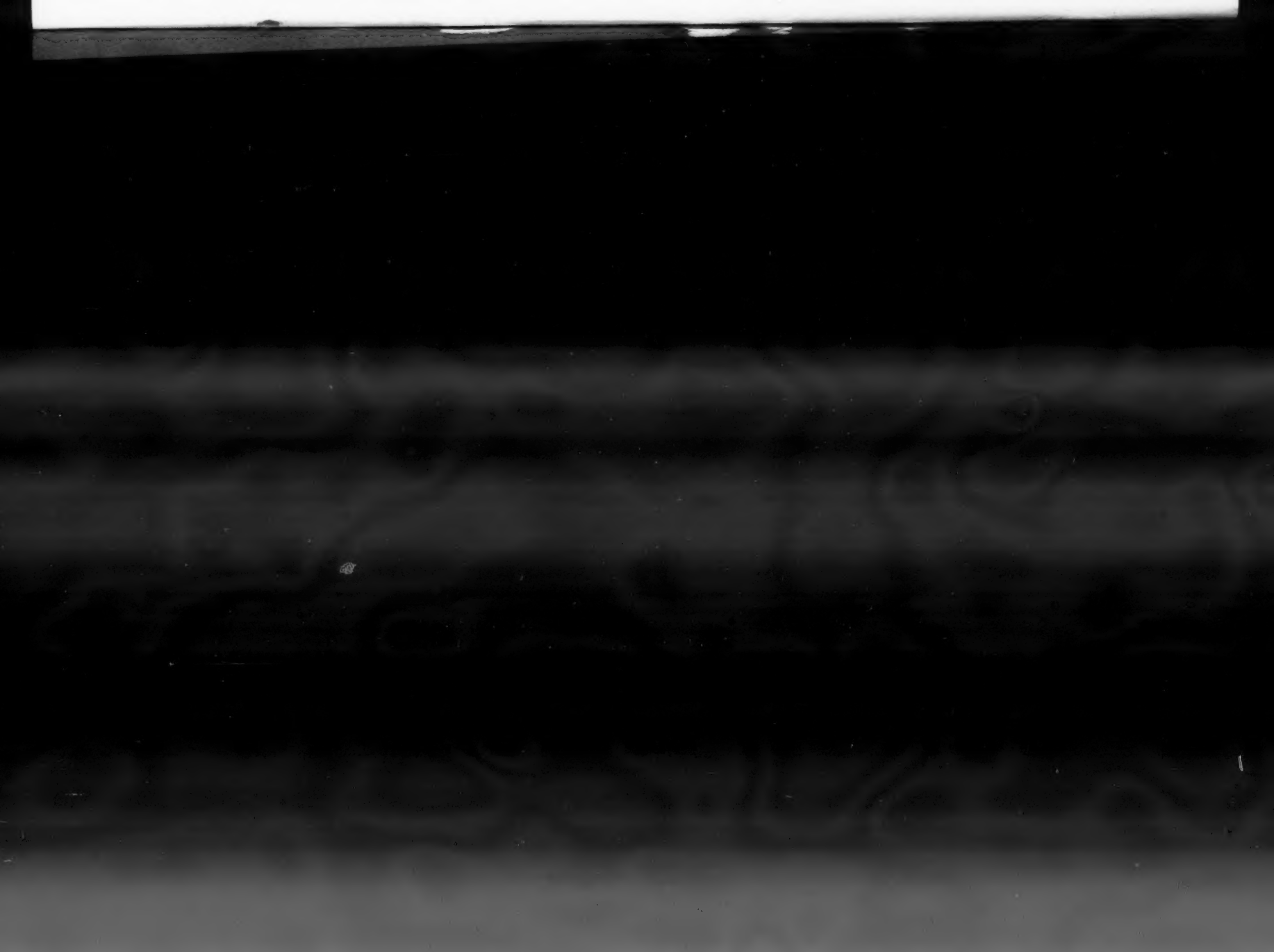
Many of the foremost American and foreign surgeons are protecting their patients against sepsis in surgery, gynecology and obstetrics by prophylactic immunization with bacterial vaccines.

A dose of an appropriate vaccine given before and after every operation will prevent many unpleasant complications.

WRITE FOR LITERATURE

G. H. SHERMAN, M.D., Detroit, Mich. *Manufacturer of Bacterial Vaccines*

Daily Users of Vaccine Use Sherman's



SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XXIV JUNE, 1917 NUMBER 6

TRANSPLANTATION OF THE URETER FOLLOWING TRAUMATISM AND RESECTION OF THE BLADDER FOR CANCER[1]

BY EDWARD STARR JUDD, M.D., ROCHESTER, MINNESOTA

URETERAL fistulæ have occurred following traumatism and following operative procedure. Removal of the kidney to which the damaged ureter belongs has not been at all unusual in the past. And this procedure will continue to be the best method of treatment for those cases in which a considerable part of the ureter is involved so that transplantation to the bladder cannot be performed. Before the kidney with the damaged ureter can be removed, it must be demonstrated that the remaining kidney is functionally sufficient. The principal indications for ureterocystotomy have been threefold: (1) injury to the ureter during hysterectomy, usually for advanced carcinoma of the cervix; (2) resection of the bladder for cancer located about the ureteral orifice; and (3) traumatism of the lower end of the ureter during difficult instrumental labor. Long (1) reports successful transplantation of both ureters following an hysterectomy for cancer of the cervix with involvement of the base of the bladder. He gives also the important features in the technique. Paton (2) reports successful transplantation of the ureter on account of traumatism which occurred during an operation for cancer of the cervix and resulted in ureterovaginal fistula. Torrance (3) reports a case of transplantation of the ureter from the vagina to the bladder 20 months after a Wertheim hysterectomy. He buried the ureter for some distance in a trough of bladder wall. His case is especially important because he demonstrated that the ureter was patent and functionating two months after the operation. In a case of difficult labor at the Lying-in Hospital, New York, Markoe (4) transplanted the lower end of the ureter to the bladder and obtained a good result. Kelly and Burnam (5) state that a ureterovaginal fistula following labor is not uncommon though they do not mention having operated on cases of this nature. Kelly reports one case of double ureterovaginal fistula in which, operating through a vaginal incision, he obtained a good result by turning both ureters into the bladder.

We have performed ureterocystotomy (1) in two instances for ureterovaginal fistula following hysterectomy; (2) on two occasions for ureterovaginal fistula following labor, and (3) in 17 cases in conjunction with resection of the lower end of the ureter and a quadrant of the bladder for cancer.

CASE 1. (102891.) A woman, 41 years of age, had had a hysterectomy performed elsewhere. The history showed that clamps had been left on and a gauze pack put into the vagina, and that urine had come into the vagina very soon after the clamps and pack were removed. Five months afterward we transplanted the ureter which was dilated to about twice its normal size, showing that there had been some obstruction.

[1] Presented before the Southern Surgical and Gynecological Association, White Sulphur Springs, West Virginia, December 11, 1916.

CASE 2. (144658.) A woman, 42 years of age, had had a very difficult abdominal hysterectomy performed in our clinic in February, 1916. In this instance, the ureter had been apparently partly tied off as we suspected at the time of the hysterectomy, and a fistula had resulted. Shortly after the hysterectomy, we made an effort to pass a catheter and found that the ureter was not patulous. At the time we operated to transplant the ureter, we found it dilated to about twice normal size and there was much scar tissue at the ureterovaginal juncture.

In both instances in which fistula followed hysterectomy the ureter was transplanted without much difficulty and the wound healed primarily. Cystoscopic examination made about three weeks after each operation showed that the ureters were open and that urine was coming into the bladder through them. Recent reports from these patients state that both have remained well. In one instance, 20 months, and in the other 8 months, have elapsed since the transplantation of the ureter.

The two cases in which ureterovaginal fistulæ developed following labor were of especial interest to us because of the rarity of the condition. They are the only two cases of the kind that we have seen. In talking with Dr. Markoe, who has had a very large obstetrical experience in the Lying-in Hospital of New York, he stated that his case mentioned above was the only one that he had seen.

CASE 3. (130856.) A woman 29 years of age, had gone through a very difficult labor three years previously. Six months after childbirth she had been operated on for vesicovaginal fistula and had obtained partial relief. Later she was again operated on by abdominal incision but obtained no further relief. At the time she consulted us, examination showed that she passed about half her urine in the normal way and had perfect control of it. In spite of this, however, her clothing was continually soiled by urine which leaked into the vagina. Cystoscopic examination did not reveal an artificial opening into the bladder and ureteral catheters could be passed into both ureters without obstruction. However, with a vaginal speculum, a small opening could be seen in the right side of the vagina just above the base of the bladder, from which urine was draining. A catheter was put into the right ureter and the urine drained through it for a number of days. Meanwhile there was no evidence of leakage through the fistula. Since the opening was so small and it was found possible to control the urine by ureteral catheter, it was thought that freshening the edges of the fistula through the vagina and placing a few stitches across the opening would probably close the fistula. We attempted to do this and left a ureteral catheter in place for ten days. During this period there was no leakage but just as soon as the catheter was removed the urine drained into the vagina as it had previously. An abdominal extraperitoneal incision was then made. The ureter was freed down to the bladder and the lower segment tied off. The upper segment was transplanted into the bladder wall. Since her labor, the patient had had several attacks of what appeared to be pyelitis, accompanied by chills and fever. She had had pain in the region of the right kidney. Ten days after the ureter was transplanted she had a similar attack, and for a few days urine drained through the abdominal wound. However, at the end of four weeks her wound was entirely healed. Her temperature and pulse had been normal for some time. Cystoscopic examination showed that the ureter was functionating, although at times there was considerable pus in the urine which came down from the right kidney. I operated on this patient in August, 1915. In a recent letter she says that since the transplantation of the ureter, she has had no further attacks of chills and fever and has remained entirely well.

CASE 4. (143263.) A woman, 27 years of age, came with a ureterovaginal fistula complicated by a vesicovaginal fistula which had been operated on twice before we examined her. Although transplantation of the ureter, performed April 1, 1916, improved her condition considerably, the last time she was seen there was still slight leakage from the vesicovaginal fistula. At this time she was about 3 months pregnant. A few weeks ago we received a report from her in which she stated that leakage of urine had almost entirely ceased and her condition had improved.

In the 17 cases of cancer of the bladder very satisfactory results were obtained by transplantation of one or both ureters. Many of these patients were operated on for very extensive cancers of the bladder; some of them have since died of a recurrence. We have been able to trace other patients for several years and during that time have examined them repeatedly with the cystoscope. In one instance, 3 years after the operation, the ureter was functionating very well. In a few cases, during cystoscopic examination, we observed that the urine flowed from the transplanted ureter into the bladder almost continuously rather than by spurts as under normal conditions. In other instances, the urine seemed to enter the bladder normally. It is probable that the continuous flow of urine was the result of a chronically infected

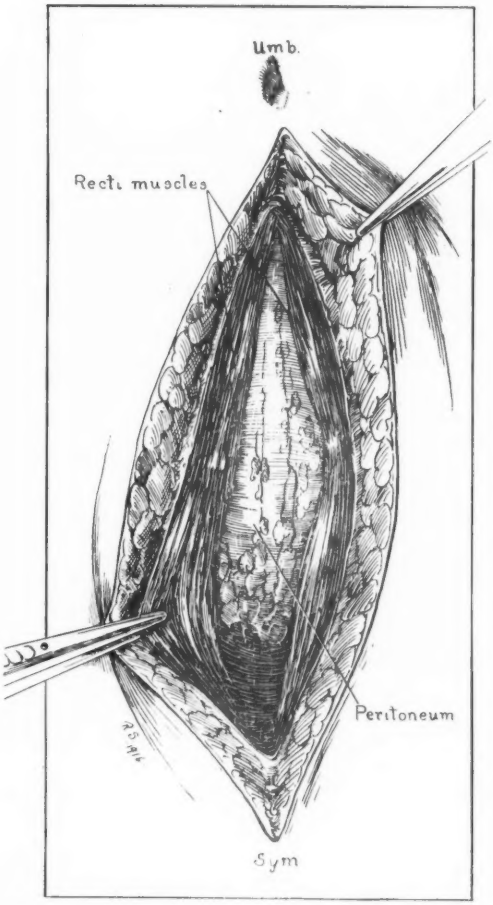


Fig. 1. Regular suprapubic incision with recti muscles cut. Bladder still in place.

ureter in which peristaltic contractions could not take place because of the thickened walls. In none of the cases was there a permanent urinary fistula, though there may have been small amounts of leakage for short periods.

In every instance in which we have been able to make a cystoscopic examination at any time after the transplantation of a ureter, we have found the ureter open. In a few cases it could not be catheterized although the urine was coming through it into the bladder. It seems entirely probable that a stricture might form and close the ureter completely, but as far as we have been able to determine,

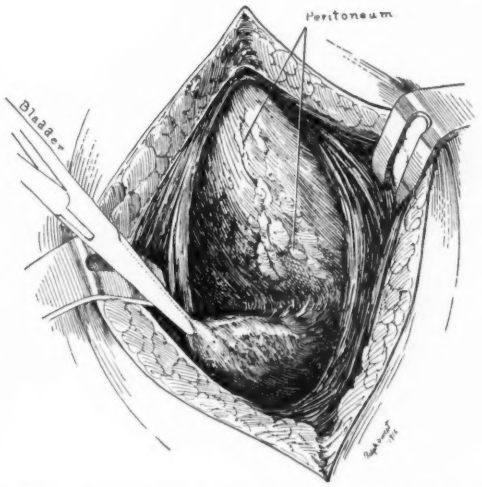


Fig. 2. Peritoneum and fat dissected from top of bladder.

this has not occurred in our cases except possibly in one case of cancer. However, in the case in which the ureter was practically ligated at the time the hysterectomy was performed, very little urine had been coming down from the ureter for two weeks previous to the ureterocystotomy. We were in doubt as to whether there would be a great deal of function in the kidney as the ureter had been ligated so long. A few weeks after transplantation of the ureter, a functional test of the kidney was made. Although there was some function on the traumatized side about five-sixths of the return was through the normal kidney. In this connection I may also mention two cases in which one ureter was deliberately ligated at the time of the operation for resection of a part of the bladder for cancer. The ureter was ligated because it was impossible to make it reach to the bladder, and since the operation had already been extensive, it did not seem advisable to transplant the ureter into the intestine. In both instances, the ureter was considerably dilated and evidently had been obstructed by the growth for some time. The ureter was ligated with the idea of doing a nephrectomy later if advisable, but in neither case was nephrectomy necessary nor was any difficulty apparent from this procedure. Both patients

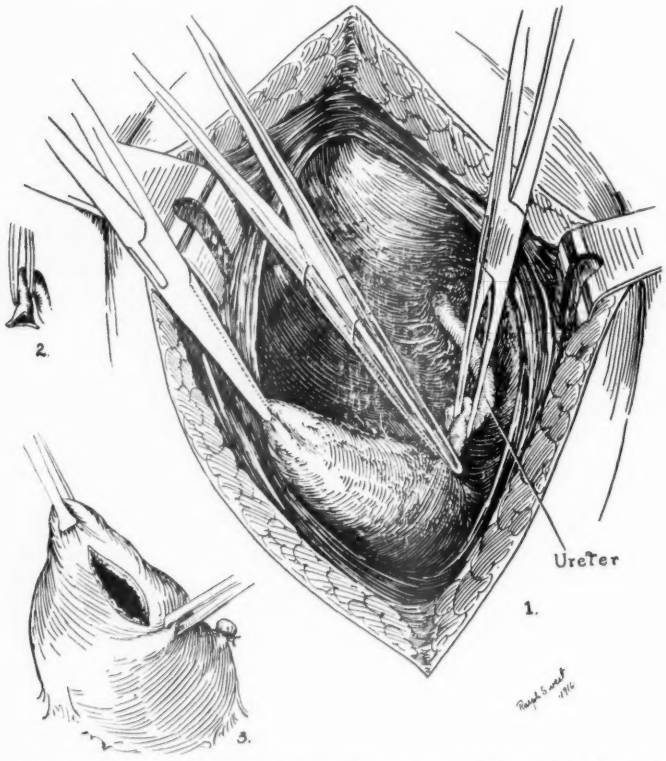


Fig. 3. *1*, From 4 to 6 inches of ureter dissected out and clamped in place prior to cutting; *2*, cut end of ureter which is to be transplanted; *3*, bladder opened and ready for transplantation of ureter.

were operated on more than a year ago and are alive at the present time. One has a recurrence in the bladder and a urinary fistula has developed from the bladder in the suprapubic wound which remained closed for a number of months after the operation. In neither case have we been able to palpate the kidneys at any time.

TECHNIQUE

The same technique was used in all of the traumatic cases. A straight rectus incision was made from the symphysis almost to the umbilicus (Fig. 1). The peritoneum was dissected back and the ureter exposed (Fig. 2). In one instance the peritoneum was opened. The ureter was liberated as far down toward the bladder as possible. In each instance there was considerable scar tissue and the dissection was continued into it (Fig. 3). The ureter was divided between clamps and the lower end ligated with plain catgut. The ureter was liberated from its bed sufficiently to make the anastomosis into the bladder free from tension. In each instance the choice of the region in the bladder for transplantation depended on the amount of freedom from tension that could be obtained. The end of the ureter was split for a short distance and a small opening made into the bladder. We think it is essential that the end of the ureter should project into the bladder for a short distance. In order to hold the ureter in place, each of the two parts of the split ureter was stitched by a plain catgut suture to the mucosa of the bladder

Fig. 4. *1*, Interrupted suture placed on the ends of the transplanted ureter; *2*, starting to close bladder; *3*, bladder closed with ureter in place.

(Fig. 4). The coats of the bladder were then accurately stitched around the ureter. We endeavored to pass the ureter obliquely through the muscular walls of the bladder so that it would simulate the normal course. We never use anything but plain catgut for the sutures inside the bladder. Fine chromic catgut is used to stitch the ureter to the surrounding structures (Fig. 5). Usually there was a little soiling from urine during the operation, and in each instance a small drain was placed in the wound. In resections of the bladder for cancer, the transperitoneal method suggested by C. H. Mayo was employed. This technique is safer and more accurate for these cases because the peritoneum can be carried with the ureter, and the peritoneal covering of the bladder makes an accurate closure. In the cases in which the transperitoneal method was used the wound healed primarily and none of the patients had any urinary leakage.

Since 1908, we have performed intravesical transplantation of one of the ureters in 17 patients suffering from carcinoma of the bladder. Thirteen of these patients were males, and 4 were females. The average age was between 54 and 55 years; the oldest patient was 67 and the youngest 33 years of age. The average duration of symptoms was 1½ years; the longest history was 5 years, and the shortest 2 weeks. In each instance, with the aid of the cystoscope, a clinical diagnosis of malignancy of the bladder was made; the surgical diagnosis was carcinoma; and the pathologist's report substantiated these opinions.

From one-third to two-thirds of the bladder was resected and the ureter transplanted into the remaining portion. Three of the 17

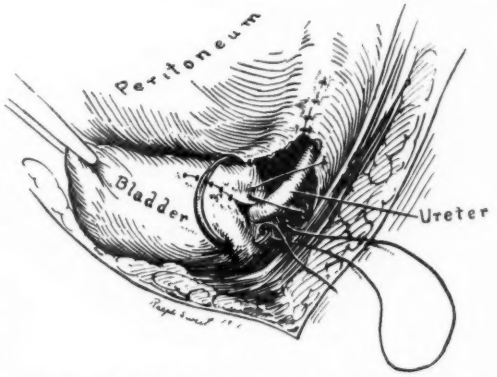


Fig. 5. Drawing tissues around ureter and bladder to hold ureter in place.

patients died in the hospital, an operative mortality of 18 per cent. One lived 5 days; one, 6 days; and one, 23 days. Necropsy showed that the patient who lived 5 days had an acute nephritis of the right kidney (left ureter had been transplanted) and left hydronephrosis. The second patient died on the sixth day from toxæmia from extravasated urine. The third death, at 23 days, was due to an acute nephritis superimposed on the chronic condition. In this instance the right ureter had been transplanted and at necropsy it was found that it had been obstructed. There was a blood-clot in the ureter and in the pelvis of the right kidney. This patient also had a marked arteriosclerosis. Eight of the patients who survived the operation have since died. The average length of life was 2 years and 1 month. One patient lived 7 years.

Patient 5756 lived 3 years and 9 months after transplantation of the ureter. His physician wrote us that death was due to carcinoma of the stomach. This patient had returned to our clinic 9 months previously, at which time his general health was fair. His prostate was very hard and firm, his inguinal glands hard, and his legs swollen.

Patient 23326 lived 1 year and 5 months. He gained in weight and strength for seven months following the operation, but died from recurrence.

Patient 24745 lived 7 years. He gained 40 pounds in the 3 years directly following the operation. His physician wrote that death was due to heart failure.

Patient 34725 improved slightly but died in 2 months.

Patient 48717 lived 2 years and 1 month. He

returned for examination 7 months after resection of the bladder and transplantation of the ureter. There was a recurrence of the carcinoma in the bladder including the area into which the ureter had been transplanted. The transplanted ureter was not visible. The area was cauterized with a high-frequency current. The patient returned 5 months later, and the high-frequency current was again applied. His last visit was 18 months after the first operation, and at that time we explored the bladder but found the condition inoperable.

Patient 86767 lived 1 year after the operation. In the meantime his symptoms had returned. One month before his death he came back to the clinic and we operated for the recurrence in the bladder and for stones. He died on the twelfth day following the operation.

Patient 92613 lived 6 months after the operation. For 3 months after the operation he gained in weight and strength.

Patient 99860 lived 5 months after the operation. At the time of the resection the carcinoma was broad-based and very extensive. Half of the bladder was resected. His general strength improved following the operation but he died of a recurrence in the bladder.

We know that five of the remaining six patients are alive at the present time. We have been unable to obtain a recent reply from the other patient, who was operated on in 1913, but when last heard from he was in good condition. The following are short reports of the condition of patients still living:

Patient 42568 wrote us 6 years after the operation that he was in good condition and had gained in weight. One year and 7 months after transplantation of the ureter, we removed a stone from the bladder, and there was no evidence of recurrence of the malignancy.

Patient 69825 had a third of the bladder resected for carcinoma, and the left ureter was transplanted. He returned for an examination 9 months after the operation and a cystoscopic examination showed the transplanted ureter functionating normally — clear urine spurted from the left meatus and there was no evidence of a recurrence of the carcinoma in the bladder. In a letter 4 years and 1 month after operation, he states that his condition is good, that he urinates 4 or 5 times a day and about once at night. He has no pain and has not observed blood in his urine.

Patient 80914 came to the clinic with a broad flat carcinoma of the bladder extending to both ureteral orifices. In August, 1913, the growth was excised and the right ureter transplanted. This woman has returned several times for examinations. Two years and 5 months after operation the cystoscope showed that the right ureter was functionating normally but there was a recurring malignant carbuncle. This was removed with the clamp and cautery. Nine months later (October, 1916) she returned, in good condition. Examination with the cystoscope showed that the right meatus was normal. There was no evidence of recurrence of the carcinoma either in the bladder or the urethra.

Patient 86191 had the right quadrant and floor of the bladder resected and the right ureter transplanted for carcinoma. She has returned four times for examination. Her last visit was in November, 1916, 3 years and 3 months after operation. Her general condition was very good. She had had some frequency and burning on urination for the past six months. Cystoscopic examination showed that the transplanted ureter was functionating normally. However, the edges of the ureter appeared to be somewhat reddened and roughened. Otherwise it was normal; and no evidence of a carcinoma of the bladder could be found.

Patient 88992 has not returned for examination but wrote to us 3 years after his operation that he felt well. He says that he urinates 3 or 4 times during the day and night, has no pain, and has not observed any blood in the urine.

From this review of our cases, we would conclude that transplantation of the ureter to another section of the bladder can be performed and the function of the kidney maintained. It seems that this is entirely feasible, that it is the procedure of choice in cases of ureteral fistula and that it is much to be preferred to sacrificing the kidney.

REFERENCES

1. Long, J. W. Ureterocystostomy; an improved technique; case of double ureteral implantation into the bladder. South. M. J., 1910, iii, 171-175.
2. Paton, E. R. Transplantation of ureter into the bladder for ureterovaginal fistula. Brit. M. J., 1907, i, 125-126.
3. Torrance, G. Successful transplantation of ureter from vagina to fundus of bladder 20 months after Wertheimoperation in which greater part of trigone was resected. J. Am. M. Ass., 1912, lix, 1376-1377.
4. Markoe, J. W. Personal communication.
5. Kelly, H. A., and Burnam, C. F. Diseases of the Kidneys, Ureter and Bladder. New York: 1914, ii, 354-355.

SOME ASPECTS OF RENAL SURGERY[1]

By J. BENTLEY SQUIER, M.D., F.A.C.S,, New York

THE past few years have added little new in the matter of operative technique in renal surgery, but much that is new in aids to diagnosis and scientific explanation of the phenomena which occur in diseases of the kidneys. Reviewing my own experience in an effort to determine the important lessons taught me, I find that a number stand out in particular prominence. Continuously evident is the frequency with which the urologic surgeon is confronted with questions requiring an intimate knowledge of general surgical diagnostic differentiation, thus emphasizing the necessity that the urologic surgeon have a broad general surgical training that he may intelligently carry on his special work.

In this connection, take for example the interrelation of renal affections to abdominal lesions: certain distinct general surgical problems are at once suggested: co-existing lesions of the gall-bladder and kidney, the relation between the urinary system and diseases of the female pelvic organs, reflex ileus of renal origin, and the jaundice of nephroptosis.

Among my series of patients who have had operations upon the kidney for a variety of conditions, about 10 per cent, previous to their renal operation, had been operated upon for a distinct and separate lesion and also many patients submitting themselves for operation for a renal condition have had at the same time another pathological condition of sufficient gravity to warrant another operation. The close anatomic relationship of the kidney to the cystic duct, gall-bladder, duodenum, pancreas, and colon hints at the probability of a mixed symptomatology as the result of a dual affection of the kidney and the upper right zone of the abdomen, and it has not been an unusual occurrence to find a renal calculus in a patient who has at the same time well-defined symptoms of gall-bladder disease. Whether such association of calculus disease is due to a chronic focal infection with resulting stone formation in the kidney and of the gall-bladder is at present difficult to say.

Rosenow's work on the selective affinity of bacteria and the rather conclusive demonstration that gall-stones are probably the result more often of a hæmatogenous infection than infection by way of the common duct or through the portal system, is noteworthy. It may also be presumed that a chronic infection capable of producing gall-stones might with equal measure produce renal calculi. In the beginning, the symptomatology of one affection might quite obscure that of the other or subjective and objective symptoms be so comingled as to present a complex clinical syndrome. So have we found that in a number of our cases it was only the occasional evidence of epigastric distress that directed attention to the gall-bladder. Previous urogenital infection with X-ray testimony seemed to indicate the possibility of the symptoms being entirely due to a lesion of the right kidney.

Other examples of the interrelation of renal affectations with abdominal conditions may be found in the close clinical association of typhilitis, mobile cæcum, chronic appendicitis, and constipation with pyelitis and pyeloureteritis.

Again, it is not uncommon for perinephritic abscess to simulate acute appendicitis with abscess. This is of some moment in view of the fact that many cases of perinephritic abscess have had a previous history of abdominal colicky pain, with nausea and vomiting that would suggest an earlier resolving appendicitis. It is probably as common for the appendix to be removed under the supposed diagnosis of acute appendicitis, and later an operation for perinephritic abscess to reveal the true condition, as to have an appendectomy performed for symptoms arising from a calculus lodged in the ureter. Recounting the point brought out by Francke of the close interrelationship of the lymphatic anatomy of the cæcum and the right kidney, and also that biologically, the cæcum is the

[1] Read before the Clinical Congress of Surgeons of North America, Philadelphia, October 25-26, 1916.

second great place of normal intestinal stasis; where the food naturally remains in the cæcum for a variable period; where the alkaline contents of the ileum become acid; where the fluidity of the intestinal contents is greatest; and where of all places in the gastro-intestinal tract the bacterial flora is at the maximum; we readily appreciate that here are the etiologic factors in the visceroptotic, stasis cases for the initiation of a typhilitis or chronic appendicitis, with pericolonic infection and resulting lymphatic infection of the right kidney. Thus is easily explained the relationship between right-sided pyelitis and conditions of chronic intestinal stasis and particularly such cases occurring in nephroptotic women. In like manner sigmoidal diverticulitis may be a causal factor in infections involving the left kidney.

If we invade the territory of the gynecologist we find that, time without time, retroverted and retroflexed uteri have been suspended or brought into the anterior position to correct a frequency of urination when the primary etiological factor was in the kidney. A knowledge of some underlying minor defects of uterine pathology has resulted in focusing the attention upon what is a secondary pathological process rather than a correct interpretation of the entire diseased picture, or vice versa, a suspended uterus has produced an apparent urinary disturbance.

The terminal ureters as they pass along the anterior vaginal wall into the bladder are subject to a number of mechanical injuries, either direct or indirect. One cannot help but refer to the splendid work of Clark upon the point of ureteric obstruction and the close association of periureteral inflammation with infections of the ureter and kidney. The resulting injuries to the ureter in obstetrics, or compression and infection from inflammatory exudate, brings with it a mechanical factor of stasis with distension of the pelvis of the kidney and, secondly, the more important factor of infection. This is entirely irrespective of whether the infection is transmitted to the kidney by the blood lymphatics or by direct extension of continuity.

"The mere passage of bacteria in or through the kidney does not, therefore, give rise to a pyelonephritis, but some other factor is required in conjunction. The virulence or number of bacteria probably plays a minor rôle, but the most important factor is some previous damage of the kidney substance by a mechanical or chemical agent." (Kidd.)

Within the last few years our knowledge in regard to many diseases of the kidney has undergone radical change: It is now questionable if infection of the kidney ever takes place by continuity up the ureter, unless the ureter is either stenosed or shows mucosal changes or the ureteral orifice of the bladder is affected. It would seem in the light of recent researches by Sweet that the so-called ascending infection of the kidney may really take place primarily through the lymphatics.

If we consider further that Kumiga has demonstrated lymphatics on both sides of the kidney which are connected with those of the diaphragm, and on the right side they are also connected with the lymphatics of the liver, and the further observation that some lymphatics of the ovary empty directly into the lymphatics of the kidney, it is at once apparent that in allied affections of the abdominal viscera, we have a sort of continuous route of infection to the kidney, with the possibility of the primary focus of disease being in the gall bladder, appendix, ovaries or abdominal cavities generally.

The relation of right drop kidney to hydronephrosis and right-sided pyelo ureteritis and pyelitis; the relation of a right-sided nephroptosis to jaundice have not been sufficiently studied nor is the clinical picture sufficiently clarified for diagnostic purposes. It will readily be seen that a drop kidney will produce the mechanical factor of stasis predisposing to infection. The anatomic relations of the descending and retroperitoneal portion of the duodenum, overlying the pedicle and the under and lower half of the right kidney, may account for some atypical cases of jaundice with gastric irritability found in patients with ptotic kidneys.

We have observed a few cases of patients admitted to the hospital with the clinical diagnosis of intestinal obstruction, in which the obstructive symptoms were so prominent as to cloud or cloak the real pathology. The

development of meteorism, nausea and vomiting, usually expulsive in character, abdominal rigidity, tenderness and pain, with and without temperature and possible leucocytosis strongly simulates intestinal obstruction. A history of the origin of the pain, or repeated attacks and a graphic outline of the distribution of pain has enabled us to determine that the apparent intestinal obstruction was one of reflex renal origin. MacKenzie has described the mechanism of this phenomenon, and Wilms and Treves have drawn attention to the fact in their monographs on intestinal obstruction.

Further study of the chemistry of the blood may reveal that the intestinal symptoms in these cases may not be purely of so-called reflex origin, but be due to retention of nitrogenous bodies in the blood because of insufficient renal secretion during the attack.

A previous paper entitled "Renal Pain" I have summarized in the following four main pathological conditions which are apt to be confounded with renal lesions by reason of the symptom of pain. They are: (1) coincident disease of the gall-bladder and ducts; (2) gastroduodenal ulcer syndrome; (3) appendicitis; and (4) affections of the large intestine.

The typical pain due to nephrolithiasis is so characteristic as to be readily interpreted. It is therefore of interest to read in Braasch's study of 251 cases of nephrolithiasis that only in 46 per cent was the pain referred to the affected kidney. Distribution of the pain being noted as follows: the region of the gall-bladder, 12 per cent; the region of the appendix, 12 per cent; in 22 per cent of cases it was referred to both sides and in 16 cases or 6 per cent, the pain was referred to the unaffected side. This transfer of pain to the unaffected opposite side is fortunately rare but it offers some diagnostic difficulty, fortunately less now than in previous days. It merely lays stress upon the importance of complete study of every case from cystoscopic and radiographic viewpoints.

Cabot in his statistical study has called attention to the very pessimistic after-results of operation for nephrolithiasis. Under his classification a person who had normal urine on chemical and microscopical examination and on whom the X-ray was negative was considered cured. In analyzing the series of cases of the Massachusetts General Hospital from the service of various operators, he reports of the 66 cases of stone in the kidney, 51 per cent were well after operation and 49 per cent were not. We believe that the statistics of individual operators will not show this lamentable percentage of failures, for these percentages are at great variance with our own.

Of practical importance is the association of renal stone with renal cancer. By analogy one may presume that continuous chronic irritation of a stone in the kidney is an etiological factor in the production of renal cancer. Statistical data would seem to bear this out. Of the total number of kidneys with cancer operated upon at the Mayo Clinic, 64 plus per cent were associated with stone and 36 plus per cent were without stone. In the true carcinomata that arise from the analogue of the wolffian body, 85 per cent of these epithelial tumors were associated with stone and presented an active proliferation of the epithelium of the pelvis extending well out into the pedicle of the kidney. In studying the sections of a carcinomatous kidney containing stones, Coryell was able to observe the gradual changes from normal tissues to inflammatory, from inflammatory to hyperplastic, and from hyperplastic to neoplastic; and he opines that it seems probable that chronic irritation brought on by the stones was the direct and etiological factor in the production of cancer.

Bilaterality of renal calculus is a subject replete with interest. After the removal of calculi from a kidney there is an inherent tendency toward re-formation which is particularly apt to occur upon the removal of calculi from both kidneys.

The question of choice of operative procedure in bilateral calculus disease is at times a puzzling one. The type of operation to be selected, whether it shall be a two-stage operation, whether the worst kidney shall be attacked first or both sides shall be attacked at the same time, is one that requires considerable surgical judgment. The further

question of nephrectomy on one side and nephrotomy on the other side will depend somewhat upon the functional capacity of the other kidney and to what degree it has been functionally incapacitated by the calculus. It has been our practice to operate upon the better kidney first and if the patient is in good condition to do both sides at the one operation.

From the many statistics published and from my own experience, I have come to the belief that the watchword in operating for calculus disease of the kidney is *conservative*. There has been too great a tendency to do nephrectomy where nephrotomy would have sufficed.

All of us have had cases which have required secondary operations for recurring calculus in the remaining kidney. In a number of patients, I have been called upon to operate on a remaining kidney two or three times for removal of recurrent calculus and yet the patient has made an operative convalescence.

Injuries to the duodenum during the performance of nephrectomy are not uncommon. The mechanism and treatment has been brought out in two very brilliant papers by William J. Mayo. He lays particular emphasis upon the importance of care and detail in performing a nephrectomy. It has been our good fortune never to have injured any of the structures subjacent to the pedicle. Every urologic surgeon, nevertheless, should be familiar with the technique of repairing such an injury, since the life of the patient may depend upon his ability to do so.

In reviewing our cases of essential hæmaturia, we have been unable to arrive at definite conclusions as to the basic etiological factor. Many of the kidneys removed for essential hæmaturia have shown macroscopically the evidence of a nephritis and upon serial sections have shown the histological evidence of atrophy and fibrosis suggesting a true nephritis. We are not inclined to believe that hæmophilia can be unilateral as suggested by Senator. The mechanism of bleeding is undoubtedly due to intermittent periods of congestion. It is true that intrinsic causes in the kidney itself, such as nephritis, infarct and so on, can readily account for it but it is not unwise to presume that there are not many extrinsic causes that would account for this unilateral phenomenon. Pathologists agree that the lesions found in essential hæmaturia are confined almost entirely to the glomeruli and represent a glomerulonephritis. These changes are identical with those which we find in kidneys which for long periods of time have been the site of chronic passive congestion. These kidney changes are probably due to a chronic focal infection elsewhere in the body.

Unilateral renal hæmaturia does not eliminate the possibility of disease of the other kidney. Disease may be present in both kidneys and only one of them bleed. Regardless of etiology we are becoming more and more inclined to be conservative in the treatment; many of our cases have been cured and remain well without further bleeding after a decapsulation. We reserve nephrectomy as a last resort, but decapsulation in a number of cases has brought about only a temporary cessation. A recurrence of hæmaturia in certain cases about 2 years following decapsulation has demanded nephrectomy.

In estimating the resistance and the operative prognosis of a contemplated kidney operation, we have found that the phenol-sulphonephthalein test and the indigo-carmine test while valuable have not been of as great importance as has been blood chemistry.

The work of Folin and Myers and Fine on blood chemistry has determined certain reactions which permit of more accurate prognosis than functional tests.

From the laboratory examinations we have been able to derive material aid in preventing postoperative complications. Nephritis, regardless of the type, is accompanied by certain characteristic alterations in the concentration of one or more of the blood constituents. Previous to taking up the study of blood chemistry with relation to operative risk we made it a rule to test out functional capacity of the kidneys and have been well pleased with the prognostic value that such determinations give us. There was, however, a class of patients in whom apparently the ordinary functional tests of renal capacity

were fallacious. We have found that the estimation of urea, uric acid and creatinin retention have been of much more decided value as a guide to operability. Occasionally a case that has responded in an adequate degree to the phenolsulphonephthalein test and which would seem to indicate the condition would be operatively safe has been operated upon and ended in acute suppression of urine and death. This has been particularly true of the type of uræmic nephritis. Various research workers have shown that in uræmic nephritis, concentration of uric acid and creatinin are far in excess of that observed in other conditions. If one considers that the rate of creatinin which is formed in the body in health and disease is practically a constant quantity and since it is most readily eliminated by the kidney, it is found in normal conditions only in small amount in the normal blood, 1 to 2 milligrams per 100 cubic centimeters, it follows then that the estimation of blood creatinin if it can readily be carried out is of immense value in the prognosis in this type of case. It would appear that the permeability of the kidney in nephritic states is lowered and becomes evident in the blood, first by an increase in the uric acid and secondly by an increase in urea, and lastly, by retention of creatinin. Therefore a case that has presented a creatinin retention of 4 to 15 milligrams per 100 cubic centimeters has been a case that has invariably developed marked uræmic symptoms. Examination of urea, uric acid and creatinin has been a matter of great usefulness in indicating the necessity for adequate pre-operative treatment and in preventing the development of some of the major urinary complications.

In this brief review of some constantly recurring renal problems and their relation to other surgical conditions, I hope to have brought out the importance to the regional surgeon of keeping in close touch with the advances of general surgery and of the laboratory, for only in this manner can he justify his claim to special knowledge or peculiar excellence.

REFERENCES

ADAMI, J. GEORGE. Chronic intestinal stasis. Brit. M. J., 1914, Jan. 24.

BARBER, WILLIM HOWARD, and DRAPER, JOHN WILLIAM. Renal infection. J. Am. M. Ass., 1915, Jan. 16.

BREWER, GEORGE E. The present state of our knowledge of acute renal infections. J. Am. M. Ass., 1911, July 15.

CABOT, HUGH. Stone in the kidney and ureter. J. Am. M. Ass., 1915, Oct. 9.

CABOT, HUGH, and CRABTREE, E. GRANVILLE. Frequency of recurrence of stone in the kidney after operation. Surg., Gynec. & Obst., 1915, xxi, 223.

CLARK, JOHN G., and KEENE, FLOYD. The relationship between the urinary system and diseases of the female pelvic organs. Surg., Gynec. & Obst., 1914, xviii, 10.

COTTON, FREDERIC J. Acute hæmatogenous infection of the kidney. Ann. Surg., Phila., 1911, November.

CORYELL, JOHN R. Renal cancer associated with renal stone. Bull. Johns Hopkins Hosp., 1915, April.

EISENDRATH, DANIEL N. Bilateral urinary calculi. Surg., Gynec. & Obst., 1913, xvii, 218.

IDEM. Reflex ileus of renal origin. Surg., Gynec. & Obst., 1916, xxii, 699.

EISENDRATH, DANIEL N., and KAHN, JACOB. Rôle of the lymphatics in ascending renal infection. J. Am. M. Ass., 1916, Feb. 19.

ELIOT, ELLSWORTH, JR. A consideration of certain co-existing lesions of the gall-bladder and kidney. Ann. Surg., Phila., 1914.

FOWLER, H. A. Renorenal reflex pain. Surg., Gynec. & Obst., 1916, xxii, 454.

FURNISS, HENRY DAWSON. Postoperative renal infection. J. Am. M. Ass., 1913, Sept. 20.

HEYD, CHARLES GORDON. Cæcal adhesions: their pathological and clinical significance. The Post-Graduate, 1913, Aug.

KRETSCHMER, HERMAN L. Unilateral kidney hæmorrhage with reference to so-called essential hæmaturia. Surg., Gynec. & Obst., 1913, xvi, 34.

MACGOWAN, GRANVILLE. Hæmatogenous kidney infections. J. Am. M. Ass., 1915, Jan. 16.

MACKENZIE, JAMES. Symptoms and their interpretation.

MAYO, CHARLES, H. Infection a cause of local and general disease. J. Ia. St. M. Soc., 1916, April.

MAYO, WILLIAM J. Accidental injuries to the descending portion of the duodenum during removal of the right kidney. J. Am. M. Ass., 1914, Jan. 31.

IDEM. Procedures following nephrectomy. J. Am. M. Ass., 1915, March 20.

MYERS, VICTOR C., and FINE, MORRIS S. The non-protein nitrogenous compounds of the blood in nephritis, with special reference to creatinin and uric acid. J. Biol. Chem., 1915, March.

IDEM. Chemical composition of the blood in health and disease. The Post-Graduate, 1914-1915.

MYERS, VICTOR C., FINE, MORRIS S., and LOUGH, W. G. The significance of the uric acid and creatinin of the blood in early and late nephritis. Proc. Soc. Exp. Biol. & Med., 1915, Oct. 6.

IDEM. The significance of the uric acid, urea, and creatinin of the blood in nephritis. Arch. Int. Med., 1916, April.

RANDALL, ALEXANDER. The etiology of unilateral renal hæmaturia. J. Am. M. Ass., 1913, Jan. 4.

SPITZER, WILLIAM M. Continuous painless renal hæmorrhage and its treatment. J. Am. M. Ass., 1914, Dec. 12.

SQUIER, J. BENTLEY. Renal pain: diagnostic and clinical significance. Surg., Gynec. & Obst., 1915, xxi, 412.

SWEET, J. E., and STEWART, L. F. The ascending infection of the kidneys. Surg., Gynec. & Obst., 1914, xvii, 460.

THE SURGICAL TREATMENT OF BENIGN NEOPLASMS OF THE BLADDER[1]

By EDWIN BEER, M.D., F.A.C.S., New York
From the Mt. Sinai Hospital, Surgical Service

FOR many years the profession has looked upon all papillary growths of the bladder with greatest suspicion. The general opinion obtained that though they might be benign anatomically they behaved as do malignant growths. This opinion was founded in great measure on the fact that when such papillomata were operated upon by the usual technique, recurrences almost regularly developed. Where there was one original tumor, dozens or hundreds might develop after the operative interference, which so frequently scattered the disease broadcast over the interior of the viscus, to take root in the injured mucosa or in other parts of the wound.

With the introduction of the cystoscopic operative treatment, a vast change took place. Nitze undoubtedly deserves the greatest credit for the advance in the therapy of these growths. His series of tumors treated transurethrally with the snare and cautery of his operating cystoscope, showed conclusively that, if radically removed without traumatism and without producing raw surfaces for tumor implantations, there is very little danger of recurrence, and that a large number of these papillomata are in no sense malignant. With this knowledge firmly established, with these views substituted for the older views, it looked as if Nitze's technique would be followed. In a short time, however, it became apparent that though the will was strong, very few could manipulate Nitze's instruments with the results he obtained. Something more simple had to be discovered, and for a number of years new types of operating cystoscopes appeared with the greatest regularity. However none of these met the situation. Since 1910, the problem seems to have been met successfully in a different way. Instead of modifying the already complex mechanism of the cystoscope, it was decided, after careful experimentation, to use the ordinary catheterizing instrument and lead through it a destructive cauterizing current. By means of properly insulated electrodes the growths could thus be cauterized with the high-frequency current without any difficulty, and the ordinary cystoscopist could get Nitze's results without acquiring the expertness demanded by the Nitze technique.

The high-frequency cauterization method is simple and effective. Cases that have been adequately treated and subsequently controlled remain free from recurrences. My original cases re-examined five and six years after destruction of the growths showed no sign of tumor in the bladders.

The technique is readily learned and has been so frequently described by me[2] that I shall refrain from going into extensive details at this time. Suffice it to say that three instruments are required, the catheterizing cystoscope, the high-frequency current (Oudin) generator, and a well insulated copper wire. The tumor is located, then the wire electrode is pushed into the papilloma and the previously tested current is allowed to play. Hydrogen gas is seen to bubble out of the growth and its fronds become blanched and necrotic. Multiple points of application are made, lasting about thirty seconds each. This concludes the session, and if there is no bleeding, as is the rule, the patient may be allowed to go home with instructions to return in about six or seven days. During this period urotropin and large draughts of water are taken, to keep the bladder clean and to assist in the discharge through the urethra of the necrotic villi. At the second session whatever viable tumor-tissue is present is cauterized, as at the previous session.

Depending upon the size of the growth the number of sessions will vary. Many growths are destroyed completely in one to two ses-

[2] J. Am. M. Ass., 1910, May 28; Ann. Surg., Phila., 1911, Aug.; Med. Record, N. Y., 1913, Feb. 8; J. Am. M. Ass., 1912, Nov. 16; Ann. Surg., Phila., 1915, June; J. Am. M. Ass., 1916.

[1] Read before the Clinical Congress of Surgeons of North America, Philadelphia, October, 23-26, 1916.

sions; others may require considerably more. I have destroyed very large growths in three to four sessions. The total application of the current necessary to destroy a fair sized growth may be only ten to fifteen minutes.

As I have repeatedly emphasized all cases of papilloma cannot be treated in this simple way. The following types of cases cannot receive the benefits of this simple therapy:[1]

1. Patients that are intolerant. This is a very small and dwindling class. With local anæsthesia and judicious use of morphine, almost every one can bear the cystoscopic manipulations.

2. Patients that bleed furiously at every introduction of the cystoscope so that no view can be obtained. These cases also are very infrequent.

3. Patients whose tumors are so placed that they cannot be reached, e. g. behind large prostatic adenomata, or in diverticula, etc. Such cases also are fortunately very infrequent.

4. Patients suffering from papillomatosis of the bladder, either primary or following a surgical operation for papilloma, which operation has implanted dozens or hundreds of growths all over the bladder-wall.

If these four groups of cases cannot be treated by transurethral high-frequency cauterization, their only salvation lies in a cutting operation, but not in such an operation as is generally in vogue and which scores so very few successes. For the older method we must substitute an entirely new technique which shall safeguard the patient against the danger of recurrences, which usually make him a worse sufferer than he was originally.

The important features of this new technique are mainly directed against the danger of breaking off pieces of viable growth which may lead to recurrences. For this purpose the intravesical operation is done entirely with the Paquelin (hooked point) cautery, the bladder is not filled with fluid before opening it, the incision in the bladder is gradually enlarged without any sponging or any rough handling and each tumor as it presents is burned to a crisp, every suspicious spot in the bladder is burned, and the edges of the opening in the bladder are similarly treated. Finally the whole operative field is thoroughly soaked in alcohol to destroy any particles of viable growth that might have accidentally broken off during the manipulations. To get an adequate exposure for such an operative technique, the patient must be in the Trendelenburg position and the bladder must be drawn out of the abdomen[2] by its urachal end, which technique allows of stripping back the peritoneum without unduly bruising the bladder and its contained growth or growths. By drawing the viscus out of the abdomen in this way the perivesical space may be well protected from implants with gauze.

The Paquelin may be so used within the bladder for the greater part of an hour without causing any more postoperative discomfort than is usually seen after a suprapubic cystostomy. I have re-examined cases treated in this most thorough manner at periods varying from several months to a year and a half after operation, and except for a slight blanching of the mucosa, there is no evidence of the extensive use of the cautery.

From my experience I feel convinced that this method of dealing with those cases that can not be treated cystoscopically, is a great improvement over the usual more or less careful cutting operation, with its repeated spongings, its grasping of the growth in rude forceps, its circumcision of the pedicle, etc. Every step in the technique at present in vogue misses the demands of the situation, every step involves breaking off viable growth and invites recurrence.

In conclusion, therefore, I believe I can honestly state that—

1. All benign papillomata that are suitable cases for cystoscopic high-frequency cauterization—and these constitute the great majority—can be definitely cured by this method.

2. Those few cases that cannot be so treated, must be operated upon and usually will be cured definitely, if the Paquelin cautery technique outlined above is followed.

[1] All malignant cases are excluded. The discussion of their treatment does not belong in this paper. In a recent publication, *Journal American Medical Association*, 1916, I have gone into this question.

[2] Full technique in paper about to appear in the *Journal American Medical Association*.

THE SURGICAL TREATMENT OF BENIGN NEOPLASMS OF THE BLADDER[1]

By EDWARD MARTIN, M.D., F.A.C.S., Philadelphia

DR. BEER has contributed a paper commendable for its brevity, remarkable for its clarity, and, from the standpoint of one appointed to discuss it, hopeless for its incontrovertible verity. He has vividly contrasted the hopeless attitude of the surgeon who used to cut papilloma, with the justified optimism of the cystoscopist who now burns it. Perhaps there is no one single surgical lesion formerly lethal, now brought under complete, safe and usually painless control, more absolutely than these papillomata of the bladder.

At the suggestion of my associate, Dr. Moorhead, we have made a slight departure from the technique advocated by Beer in that we customarily leave a much longer interval between applications which are at times done as an office procedure. The advisability of this occurred to Moorhead from the circumstance that a patient who was asked to report back at the end of seven days was unable so to do and at the end of six weeks his very sizable papilloma had almost disappeared. In some of these cases, if not all of them, the complete effect of the fulguration is not immediately realized, nor have we had any occasion in the pure papillomatous cases to regret this longer interval between applications. Bleeding and obstruction by sloughs at times constitute complications the management of which may require skilled attention. Hence these patients should be kept within reach. We have accomplished sacral anæsthesia in some cases with entire success, but twice it was followed by such long lasting lumbar pain that we now restrict its use to the more irritable cases, and repeat it not more than four times.

Patience, gentleness and local anæsthesia plus morphine usually seem adequate.

[1] Discussion of the paper read by Dr. Edwin Beer, Clinical Congress of Surgeons of North America, Philadelphia, October 23-26, 1916.

DIAGNOSIS OF URETERAL DISEASES WITH THEIR SURGERY[1]

By BRANSFORD LEWIS, M.D., B.Sc., F.A.C.S., St. Louis

With many genito-urinary lesions the pathological diagnosis of the existing condition of the organs only does not fulfill requirements, either for diagnostic or therapeutic purposes. "Pyonephrosis" indicates a distended, pus-filled kidney but does not tell of the origin of that condition. Pyelitis or ureteritis or hydro-ureter may occupy a similar position, leaving much to be desired in the way of diagnosis, if we fail to recognize the source and mode of development — pathogenesis.

It is deemed logical and advisable therefore in considering the subject of diagnosis to include a study of the derivation and mode of development of the pathological conditions embraced under the topic assigned to the writer; and advert to some of the direct methods of attaining diagnosis later. It will be apparent, however, that the subject assigned is too large to be covered amply; and that only certain phases can be touched on in the time at our disposal.

Ureteral diseases are congenital and acquired in origin, and primary and secondary in their nature. Those demanding practical surgical consideration are, chiefly, the following:

1. Infection.
2. Inflammation.
3. Obstruction, (a) from stricture; (b) from kink; (c) anomalous vessel; (d) pressure from adjacent tissues (tumor, scar tissue, etc.); (e) calculus; (f) reduplication; (g) malignant growth.

Infection. It was formerly believed that ureteral infections were uniformly derived from the bladder. Ascending infection was considered as the regular mode of attack; this idea prevailed, for a time even, for tuberculosis. But tuberculous infection was later recognized as coming through the blood and kidneys, and latterly the other more common infections are gradually being ranged in the same category.

While it is obviously possible for infections to travel by mucosa from bladder to ureter, it is probable that the hæmatogenous is by far the more frequent mode of transit, and that the usual source is more distant than the bladder; in other words, that the initial points of invasion are diseased tonsils, teeth, and nasal sinuses and local points of suppuration at various parts of the body.

From these points the infecting organisms are carried by the blood to the kidneys, followed by descending infection of the ureters. Hunner[2] has contributed valuable observations along these lines. In 50 cases of ureteral stricture studied by him, only 2 could be ascribed to gonorrhœal infection, and in only 3 could previous cystitis be traced. In one of these a stone had been present to account for the cystitis.

Furniss[3] believes that such infections are of hæmatogenous origin through the kidney, with resultant pyelitis, ureteritis, and secondary cystitis.

It will be noted that these theories have a marked bearing on both questions of diagnosis and treatment. If true, they impel the investigator to seek the originating focus of the infection as the cause of ureteritis or of ureteral stricture; and point the therapeutic endeavor in an entirely different direction from that which would be based on the view that these conditions are of local rather than of focal origin.

A patient of the writer who had repeated attacks of pyelitis with ureteritis, chills and temperature running to 104°, was several times cleared up under the influence of hexamethylenamin therapy internally and lavages locally, administered through the ureteral catheter. But each time when the urine became perfectly clear and he was permitted to go out of the hospital, there would be a relapse, with the same sequence of chills, fever, and loading of the urine with pus and bacteria (colon), traceable to the kidney pelves. Pyelitis was plainly demonstrable, acute and severe.

[2] Hunner, J. Am. M. Ass., 1911, lvi, 937; South M. J., 1916, 616.
[3] J. Am. M. Ass., 1912, lix, 2051.

[1] Presented before the Clinical Congress of Surgeons of North America, Philadelphia, October 23-26, 1916.

While the patient insisted that he had no throat trouble, and my friend, Dr. Fred Pfingsten, who was then consulted, was dubious about the presence of sufficient tonsillar disturbance to be of moment in the case, it was concluded between us that the patient should be given the benefit of the doubt and the tonsils should come out.

Both tonsils were removed by Dr. Pfingsten, who found the crypts filled with cheesy, purulent secretion. In one there was a well-defined pus pocket, a dilated crypt from which there had been no drainage. After this operation the urinary tract was permanently cleaned up and sterilized and there has been no recurrence of the infection in the ten months that have elapsed since.

In another patient (female) who is subject to recurrent attacks of bacteriuria, it has been found that each such attack is preceded by re-lighting of a nasal sinus inflammation that has been difficult of relief. And that with relief of the sinus involvement there is each time immediate and complete clearing of the urine and disappearance of certain irritating symptoms connected with the bladder. Thomas[1] says that all such infections, except those due to obstruction in the lower urinary tract, are hæmatogenous.

This view of the origin of ureteral infections and ureteral stricture naturally serves to dim the importance of congenital influences in their production. Many cases that have been considered as merely developmental anomalies are now viewed as due to infections and their sequences.

Ureteral dilatation. The effects of obstruction at various points in the urinary tract and its sequelæ in the shape of back-pressure, distention, dilatation, sacculation, etc., are universally recognized and are pretty well understood. But the dilatation and ultimate functional destruction of ureter and kidney that occurs *without recognizable obstruction* has been the source of mystification and speculation with both surgeons and pathologists. As long ago as 1909, Byron Robinson[2] remarked on the surprising frequency with which, in a thousand autopsies, widely dilated ureters and other evidences of obstruction would be met with and yet no obstructive condition could be demonstrated. While no cause could be discovered in such cases, it was evident, he declared, that a potential factor must have existed.

A similar condition of dilatation without demonstrable obstructing factor has been met within the living by many different observers and various hypotheses have been submitted to explain it.

Israel[3] suggested that the obstruction might be dynamic, coming from irritability of the bladder and frequent attempts to void, associated with spasm of the sphincter.

Fedorow (quoted by Kretchmer[4]) offers the explanation that in his case the existing hydronephrosis was due to atony of the ureter, and that the atony of the ureter was due to stasis of the urine in the kidney (hydronephrosis). In other words, that the ureteral atony was due to hydronephrosis and the hydronephrosis was due to the atony. This explanation is hardly satisfying. It reminds one to the perennial speculation as to whether the chick first came from the egg or the egg from the chick.

Bacharach[5] expressed his belief that in two cases observed by him the cause of the ureteral atony must have been congenital insufficiency of the ureteral sphincter, rather than an ascending infection, which he considered secondary.

Kretschmer, who reports a case of ureteral dilatation without obstructive lesion, shares this view. He considers such a condition as very rare, and also declares that, "up to the present time the pathogenesis is unknown."

Modern cystoscopy and radiography have shown, I believe, that the condition under discussion is not at all a rare one. Kretschmer himself alludes to the records of 16 such cases, reported by various authors; while Braasch[6] shows many reproductions of pyelograms of ureteral dilatation occurring independently of any obstructive lesion. This author (Braasch) without reservation divides dilata-

[1] Thomas. Urol. & Cutan. Rev., 1916, xx No. 3.

[2] Internat. J. Surg. 1909, Dec.

[3] Israel. Chir. Klin. der Niern. Krankh., 1901, p. 103.

[4] Kretschmer and Greer. Insufficiency at the ureterovesical junction. Surg., Gynec. & Obst., 1915, xxi, 228.

[5] Bacharach. Beitr. z. klin. Chir., lxxviii, No. 2.

[6] Braasch. (a) Cystoscopy and urethroscopy, by Lewis & Mark, 1915, p. 90; (b) Tex. St. J. Med., 1913, Feb.; (c) Pyelography, 1915.

tions of the ureter into two classes: (a) obstructive or mechanical, and (b) inflammatory.

In this he seems in accord with the views of Karoffa-Korbut[1] who in 1908 declared that in some cases atony of the ureter was a result of an inflammatory process (ureteritis ascendens) and that it could lead to pyelectasia and hydronephrosis.

Braasch's belief is that "whenever the renal pelvis or ureter become inflamed a change takes place in the wall which causes dilatation."

The inflammation superinduces infiltration of the ureteral wall which increases its diameter and caliber and at the same time weakens it, undermining its elasticity and resilience, finally leaving it lax and flaccid; a dilated ureter without obstruction.

The wide difference between the treatments appropriate for the two kinds of ureteral dilatation, obstructive and inflammatory, will readily be appreciated. In the mechanical form the obstruction must be relieved. In the inflammatory form the infection and inflammation must be removed and other militating agencies neutralized.

While sharing the views of Braasch regarding inflammatory dilatation of the ureter, the writer at the same time wishes to suggest the influence of additional factors in promoting the condition. In both men and women potential agencies for obstruction exist, that are not always obvious to cursory examination. Pertaining to similar conditions involving the bladder (atony of the bladder with dilatation), the writer[2] has studied the subject elsewhere with the conclusion that while the cause is not patent in many such cases, it nevertheless is present and must be sought for by better and more refined methods of investigation than have been used; and is often to be found in unlooked for sources, such as silent spinal syphilis or other hidden derangements. In women a fertile source is to be found in the form of a tight or spasmodically contracting urethra, together with cystitis colli, so prevalent and often so formidable, reflecting its effects onto the ureters and promoting infection and distention there.

In men there are many instances of obstruction at the vesical neck that are more or less obscure or unrecognizable; that are not made evident by prostatic enlargement or other outspoken deviation. Such conditions have masqueraded under the terms, prostatism sans prostate; prostatism without enlargement; contracture at the vesical neck, etc.

Moreover, cases that had been abandoned as incurable (atony, retention, enuresis) were reclaimed to urinary competence and control through the *solution of these questions of the origin and nature of the disability*. No case of so-called permanent vesical atony was considered or conceded as "idiopathic"; no cases were acknowledged to be without a cause. Non-recognition of the origin was ascribed to inadequacy of investigation rather than to absence of cause. The importance of this phase of diagnosis in urinary disorders is thus made evident.

Ureteral obstruction. While the frequency and importance of the congenital origin of ureteral strictures are somewhat discounted in the remarks previously made, this must not be understood as discrediting their existence, which is established beyond a doubt. Congenital ureteral strictures are very real and very disastrous in many instances, as is made evident in a most instructive study of 56 cases by Bottomley.[3]

Congenital strictures have been observed to occur in the form of folds of ureteral mucous membrane, causing valvular effects; as dense infiltrates and narrowings involving more or less length of the ureter, even to the extent, sometimes, of converting the canal into a solid, impermeable cord;[4] and also a narrowing of the ureteral orifice, which being repeatedly distended, stretched, and propelled into the vesical cavity, finally assumes the form of a globular cyst (ureterovesical cyst), ballooning out into the bladder with each effort at expulsion of urine by the affected ureter. It may be plainly seen through a cystoscope. This is a condition that pertains to the *mucous membrane* of the orifice, rather than to the ureteral canal; never-

[1] Karoffa-Korbut. Folia Urol., 1908, ii, 167.

[2] Bransford Lewis. Studies in obscure forms of prostatic obstruction and vesical atony. Ann. Surg., Phila., 1915, March.

[3] 'Certain congenital strictures of the ureter.' Ann. Surg., Phila., 1910, April.

[4] Tyssedre. Thése de doct., Par., 1892.

theless, the effect is that of ureteral stricture. It may be either congenital or acquired.

The preceding remarks pertaining to the origin of ureteral infection are equally applicable to ureteral stricture, the acquired form of which is but a sequel of previous infection and inflammation.

With reference to the direct diagnosis and treatment of ureteral stricture, it may be said that the symptoms of such cases resemble somewhat those of ureteral stone but do not present the suddenness of onset of the latter, are usually not so excruciatingly severe as in stone colic, and display a tendency to periodicity, often related to menstruation in women. Symptomatology alone does not permit the making of a differential diagnosis but typical symptoms are quite characteristic for one who has seen much of such cases. The final diagnosis must rest on exploration, conjointly with the cystoscope, the ureteral catheter and radiography.

One fact should stand out prominently and be well understood: That no one of these methods should be relied on as alone capable of affording a differential diagnosis. In all obscure cases or those in which there is any doubt as to diagnosis, *all* of the several methods and means for attaining diagnosis should be employed. The cystoscope may or may not reveal disturbance about the orifice of the ureter on the side affected: congestion, swelling of the mucosa, etc. Entrance of the catheter into the strictured ureter usually elicits evidence of marked suffering by the patient, who at once recognizes the resemblance of this pain to the attacks previously experienced. This is further accentuated when the catheter comes in contact with the diseased part of the canal, engages in the stricture and finds passage through it or is held up there in transit. In case the operator succeeds in passing the point of obstruction he should not lose advantage of the opportunity this affords of measuring the capacity of the pelvis and then injecting the ureter and taking a pyelogram. This is apt to give valuable evidence both negative and positive. It may show the absence of stone shadow, and the presence of dilatation of the ureter above and also the point of narrowing (stricture) below. The pyelographic evidences pertaining to the kidney and its pelvis may also be obtained at the same time: showing diagnostic features permitting differentiation between obstructive and inflammatory distention of ureter and pelvis. According to Braasch,[1] the pyelographic outline of *inflammatory* dilatation is differentiated from that caused by *mechanical obstruction* by its irregularity of contour, and by reason of the fact that the changes are confined largely to the *calyces*, the renal pelvis itself not showing the distention that is occasioned by the obstructive form.

The calyces are rounded, become club-shaped and the minor calyces become obliterated.

Ureteral obstruction from kinking of the ureter and from the crossing of the ureter by anomalous vessels is generally well understood. The former (kinking) comes mainly in connection with movable kidney, is intermittent, and with intermittent symptomatic expressions, while the latter (anomalous vessel) is congenital but takes years to bring about its ultimate effects of back-pressure, distention, and other sequelæ of destructive character.

Obstruction occurs in ureters from the pressure of adjacent tumors; scar tissue; from traumatism connected with operations on the neighboring organs (ovaries, uterus); and from malignancy. These need not be discussed here. Of more practical nature for review are some questions connected with ureteral stone. These are chiefly two: diagnosis and treatment.

Diagnosis of ureteral calculus. With ureteral stone, as with other pathological conditions of the urinary tract, symptomatology does not serve as a satisfactory or reliable basis for diagnosis. Its chief value consists in pointing the way to methods of investigation that should prove determinative. As in the case of ureteral stricture, such methods are chiefly cystoscopy, ureteral catheterization, and radiography.

A swelled and inflamed ureteral meatus as seen through a cystoscope (meatoscopy) may be a classical indication of ureteral stone

[1] Loc. cit.

above; but the inflammatory appearance may be absent, or the stone may be absent when the swelled meatus is present. So that, like other valuable documents in evidence, this must be reviewed simply as one of several characteristic indications that may or may not be present.

Ureteral catheters are blocked in transit from causes other than stone; namely, from bends or contractions (spasmodic or organic) in the ureter, from tortuosity, etc. While, on the other hand, a stone does not always block the passage of a catheter but often permits it to pass without a hitch.

Misleading radiography, used alone, has induced many a surgeon to open the ureter in quest of a stone that did not exist; and that radiograms, even supposedly good ones, have failed to disclose stones actually present, is attested by many. Geraghty and Hinman [1] mention that in 67 cases studied by them careful and repeated radiograms being obtained, and only those accepted which were considered perfect, radiography missed the stone in fifteen cases, or 22.4 per cent. In all stone was subsequently demonstrated to have been present.

Referring to the same question, Braasch [2] says: "It is doubtful if an accurate diagnosis of stone in the ureter can be made from roentgenographic data alone in more than 60 per cent of cases."

Errors in diagnosis relate to: (1) Pronouncing stone present when really absent; and, (2) failure to detect stone when present.

Without discussing the value and force of symptomatology of ureteral stone which are erratic and uncertain to an extreme degree, it might be well to discuss the bearing of physical examination on the above errors.

1. Diagnosticating stone when none is present. This formerly was an error committed by those who placed too much confidence in the message of the symptoms — ureteral and renal colic, transmitted pains; blood and pus in the urine. But latterly the error has been promoted in certain instances by the findings of radiography, unchecked by co-incident ureteral catheterization and other methods of control. It would be interesting to know how many patients had been operated upon without any stone being found. However, that source of error is gradually being lessened by the more careful methods of search now in vogue and the practice of using ureteral catheters (radiographic) and, occasionally, collargol or thorium nitrate injections in connection therewith. Steroscopic radiography assists, also, in localizing as to whether it be within the ureter or outside of it, the channel of the ureter being occupied by a radiographic catheter.

2. Failure to detect stone when present. In connection with the fact that radiography fails to delineate a shadow of some stones though present, an instance occurred in the writer's observation that might have proved misleading but for the blocking of the catheter's passage, plus the marked symptomatology present. In the first radiogram taken, the stone shadow was lodged just behind the pelvic bone and did not show but the dimmest outline; but in a later one, by using a little different angle in taking the radiogram the stone appeared below the bone shadow and came out clear and strong, fixing the diagnosis beyond a doubt.

The conclusion to be drawn is that it is incumbent on the investigator to utilize *all* of the approved methods available for this work, and to use them in connection with one another, and in their proper sequence.

Cystoscopy, ureteral catheterization with an opaque catheter, radiography, supplemented if necessary with a wax-tipped bougie, at proposed by Kelly, are the approved steps for determining the diagnosis in ureteral stone.[3]

To sum up:

1. Ureteritis should be treated by both local and general measures, a possible focus of infection (tonsils, teeth, etc.) being searched for most assiduously, found and disinfected, while at the same time in chronic

[1] Geraghty and Hinman. Ureteral calculi; diagnosis and newer methods of intravesical treatment. Surg., Gynec. & Obst., 1915, xx, 515.

[2] Braasch. Stones in the ureter. Tr. Am. M. Ass., 1915, June.

[3] In using the wax-tipped catheter in the male with modern cystoscopes, the method suggested by Harris is advisable; namely, that the catheter be introduced first, so that the wax does not come in contact with any metal of the instrument. The sheath and telescope are then threaded over the catheter. With the author's universal and operating cystoscope (Wappler model) the waxed catheter may be introduced through the wide open sheath, the telescope then being threaded over the catheter.

cases, ureteral lavages are given occasionally through the ureteral catheter. For this purpose silvol, argyrol, silver nitrate, etc., are used.

2. If the ureteritis is demonstrated to be due to a foreign body (stone) or stricture in the ureter, especial attention must be given to these.

3. The therapeutic requirements in both stone and ureteral stricture are being fulfilled in an increasingly large proportion of cases by cystoscopic operative measures. These should therefore be applied before resorting to the more radical measures incident to open operation.

4. Cystoscopic measures for assisting the release of ureteral stone and the relief of ureteral stricture consist in dilatings of the ureter with both flexible and metal dilators, incision of the ureteral meatus when necessary, the application of ureteral forceps, and high-frequency electric current.

5. Cystoscopic measures for the relief of ureteral stricture consist in the use of gradually increasing dilatings by means of (a) ureteral sounds, bougies or catheters; (b) metal dilators of various sizes and patterns, used in a manner to suit each individual case; (c) ureteral scissors, with which a contracted orifice may readily be enlarged by incision on its dorsal aspect.

6. If the orifice be wholly closed or present the ballooning known as ureterovesical cyst, it may be opened up by means of the scissors or the high-frequency electric current (d'Arsonval, bipolar, preferred).

7. If destruction of the kidney above the stricture is so great as to render the saving of the kidney ineffectual, it should be removed by open operation, the ureter being abandoned to become obsolete.

8. Where the ureteral stricture proves unresponsive to dilating measures, it may still be saved by plastic measures or by resection and anastomosis; in default of which nephrectomy becomes a necessity.

9. A stone presenting at the lower ureteral orifice is removable by cystoscopic measures (dilators, scissors or forceps) with practical certainty, and should always have the benefit of this procedure instead of the epicystotomy which has been practiced in such cases.

10. In case the stone is located higher up in the ureter, the cystoscopic measures for its removal are, in consequence, the following: The passage of a ureteral catheter with the intent of dislodging the stone from possible attachment to the adjacent ureteral wall; the injection of liquid alboline or vaseline through the catheter, the passage of successive sizes of dilating bougies; the introduction of metal dilators, applying their dilating force most strongly at the point of narrowing just below the stone; or the use of the movable probang of Cunningham.

These measures may be rendered less disagreeable to the patient by making a preliminary injection of alypin or other sedative solution into the ureter through the ureteral catheter.

11. Following the use of these measures the patient should be cautioned to urinate through a strainer of some kind each time in order to catch the stone if passed voluntarily.

12. The stone being expelled by these means, the patient is practically well and capable of returning home without delay. But if the cystoscopic measures, repeated two or three times, prove unsuccessful the patient is in no worse condition than previously for the open operation that should then be adopted.

13. In the cutting operation for ureteral calculus the extraperitoneal incision is much to be preferred over the transperitoneal. Preliminary ureteral catheterization often facilitates the finding and identification of the ureter and stone.

14. If the stone be located so low in the ureter as to make access difficult it is advisable to use a ureteral forceps or one of the ureteral instruments through the cystoscope with the purpose of pushing the stone back up the ureteral channel until it comes within the operator's reach through the external incision.

15. Complete stripping of the ureter in its exposure is inadvisable because of the interference with nutrition it is liable to entail.

16. It is usually not necessary to stitch the ureteral wound-edges after removal of a stone; but a drain of some sort from the ureter to skin surface promotes safety.

INFECTIONS OF THE BLADDER WITH SPECIAL REFERENCE TO LOCALIZED RESISTANT AREAS OF CYSTITIS[1]

By J. T. GERAGHTY, M.D., F.A.C.S., Baltimore
From the James Buchanan Brady Urological Institute of the Johns Hopkins Hospital

OUR present knowledge of diseases of the bladder is due in large part to a single instrument — the cystoscope. Since the introduction of the cystoscope by Nitze, our diagnostic methods have rapidly developed and instruments for the treatment of vesical conditions through the urethra have multiplied rapidly. By means of the many ingenious instruments which have been devised, it is possible to cure many vesical conditions which a few years ago would have demanded grave surgical procedures. Diagnostic methods have now become so precise that suprapubic cystotomy simply for the purpose of diagnosis is rarely performed in well conducted urological clinics. The information obtained by the employment of the different procedures available to the urologist is much fuller and more accurate than can usually be obtained from an exploratory suprapubic cystotomy. It is only in rare instances that the urologist is now obliged to fall back upon a cystotomy for the desired information and usually resorts to this procedure with a feeling of chagrin. It is my purpose to review rather briefly our present views regarding infections of the bladder but particularly to call your attention to a type of localized cystitis which has received but scant attention until recently.

Bacteriology. Bacteriological studies show quite consistently that organisms of the colon group are the most frequent cause of cystitis both acute and chronic; while all of the pyogenic bacteria are capable of producing inflammations of the bladder, most of the known forms of bacteria have been isolated by investigators at one time or another. In many cases the infection is a mixed one. Bacteriological studies have further shown that the old idea is no longer tenable that an acid cystitis is usually due to the tubercle bacillus. The urine in the vast majority of cases of simple cystitis is acid. The colon bacillus, the staphylococcus, different varieties of the streptococcus, the gonococcus, and many other organisms are usually associated with an acid cystitis, while organisms belonging to the proteus group are usually associated with an alkaline cystitis and produce the ammoniacal, ropy, mucoid condition of the urine which is so well known. It may be of some interest to note that there is a peculiar specificity displayed by different bacteria for different parts of the urinary tract.

For example, the primary focus of tuberculosis in the urinary tract is practically always in the kidney, and even then it displays a predilection for certain portions of the kidney, the earliest lesions being usually found in the upper pyramidal areas. It is now universally recognized that vesical tuberculosis is practically always secondary to infection in the tract above. In fact, the bladder in many cases of advanced renal disease entirely escapes and in other instances, even when quite severely involved, on removal of the tuberculous kidney the bladder lesion tends to disappear spontaneously. The anterior urethra, on the other hand, is very resistant to tubercular infection and the disease rarely becomes engrafted on this portion of the tract. The gonococcus is one of the few organisms which is capable of infecting the anterior urethra without predisposing trauma to the mucosa, but while the gonococcus has a special predilection for the urethral mucosa of both the anterior and posterior urethra, the bladder, with the exception of the trigonal portion, is vary rarely involved. In most cases of so-called "gonorrhœal cystitis," the infection is limited to the trigone. Diffuse gonorrhœal cystitis is rare, while gonococcus infection of the kidney is even more rare and bacteriologically proved cases of gonorrhœa of the kidney are indeed few. The typhoid bacillus attacks principally the kidney and usually produces a lesion of very mild degree, the result of which is nothing more than a bacilluria, a pyuria being

[1] Presented in the symposium on genito-urinary surgery, Clinical Congress of Surgeons of North America, Philadelphia, October 24, 1916.

rather uncommon. Typhoid cystitis and typhoid posterior urethritis are most unusual. The colon bacillus, staphylococcus streptococcus, pyocyaneus, and other organisms attack the kidney, bladder, and posterior urethra, apparently with equal facility but rarely the anterior urethra. (Although the urine may be loaded with colon bacilli, staphylococci and other organisms, one rarely sees infection of the mucosa of the anterior urethra from these organisms.) There is one other organism which deserves special mention because of its peculiar action on the urine. I refer to the micrococcus ureæ. This is an organism which implants itself apparently only in the prostatic urethra, does not set up cystitis and apparently is not associated with renal infections. The result of infections with this organism, although it is an organism of slight pathogenicity, may lead to rather uncomfortable symptoms. This organism has the ability to split urea with the liberation of ammonium carbonate. The freeing of ammonium carbonate renders the urine alkaline and results in the marked precipitation of triple and dibasic phosphates, causing these patients to void large quantities of sand. It may be remarked that this infection, while not leading to anything more serious than slight irritation, is nevertheless extremely resistant to treatment—and the prognosis has been bad in my experience as far as its ultimate eradication is concerned. With the possible exception of the tubercle bacillus, there is nothing characteristic in the lesions produced by the various bacteria. It is impossible from the symptoms or the pathology of a vesical lesion to determine the variety of the invading organism. The colon bacillus, for example, may be in one case associated with a most intense, even gangrenous cystitis, but at other times the infection may be of a very mild type indeed; similarly with the staphylococcus, streptococcus, and the numerous other organisms which are found. In so far as our therapeutic measures for combating vesical infections are concerned, a knowledge of the organism concerned in the infection has proved of comparatively little value.

From time to time special drugs have been introduced with claims of having a specific action on particular groups of bacteria, but in our experience we have been unable to substantiate the specificity of any of these drugs for any special group of bacteria. The discovery of special drugs with a special action on definite groups or varieties of bacteria still remains a problem for the future.

The management of a case of simple acute cystitis, as far as the diagnosis and treatment is concerned, seldom entails any difficulty. An examination of the urine in conjunction with the history and symptoms is usually sufficiently definite. The treatment is comparatively simple. Our main endeavor in the treatment of these cases should be to place the bladder at rest as much as possible, and this is done in two ways. First, by the liberal employment of sedatives, resorting if necessary to the plentiful use of morphia or preferably pantopon; secondly, the decrease of the bladder activity by decreasing the amount of water ingested. The mistake is so frequently made of forcing water on these patients. If one were to purposely adopt a procedure which would aggravate the condition he could not select anything more efficacious. The water should be decreased to the absolute needs of the individual, so that the bladder will not be constantly obliged to expel the rapidly accumulating urine. In order to combat the increased acidity of the now concentrated urine, alkalies should be given to the point where the reaction becomes alkaline. Urotropin is useless; if the urine is allowed to remain acid, the formaldehyde liberated would but add to the irritation and if it is rendered alkaline the urotropin will not be decomposed and consequently no formaldehyde will be present. The use of the drug in acute cystitis cannot be said to have much value. Active treatment, such as instrumentation, irrigations and instillations during the acute process are usually more harmful than beneficial. When the symptoms do not subside and the infection persists, it is usually an indication that there is present some complication which is responsible. In such cases a careful investigation must be made to determine this factor. In some it will be found that the cystitis is but

an expression of a renal infection above, or there may be some malformation or deformity in the urinary tract which is not allowing complete emptying or evacuation of the vesical contents. In the vast majority of chronic or long-resisting infections of the bladder, it will be found on investigation that the infection is secondary really to some other focus in the genito-urinary tract. Everyone is familiar with the rapidity with which a cystitis will clear up when an unsuspected stricture or a pyelitis is discovered and properly treated. At other times the infection is dependent upon some form of obstruction at the vesical orifice. Occasionally the cystoscope will reveal the presence of a diverticulum which has become infected and owing to the lack of proper muscle in the diverticular sac, the contents of the sac are never completely emptied and it serves as a reinfecting focus for the bladder itself. A small series of recurring and persistent urinary infections, recently reported by me, which had stubbornly resisted all efforts, were finally entirely cured by opening and drainage of the seminal vesicles the latent infection in these organs keeping the bladder infected. Occasionally an infected utricle is discovered and elimination of the infection from this source is followed by disappearance of the infection from the urinary tract or again the prostate is at fault. It is now pretty thoroughly understood that before one can begin the intelligent treatment of an infection of the urinary tract that an investigation of the whole tract must be undertaken. In most cases the successful treatment of a case of chronic cystitis will depend upon the ability of the physician to locate the intravesical or extravesical factor which is responsible for the continuance of the infection, and in most instances if this factor can be rectified the cystitis will promptly be cured. The treatment of chronic cystitis has largely become a matter of the treatment of associated conditions or lesions, and the prognosis in any given case will depend upon the possibility of removing the contributing cause.

Localized cystitis. We are obliged to admit, however, that in a definite number of cases the failure of the vesical infection to disappear spontaneously is not due to any extravesical factor. These form a very interesting group of cases. In most of them the disease is not a diffuse cystitis but a localized affair with normal mucous membrane lying between the infected areas, the areas may be single or multiple. Sometimes the lesion is a localized area of reddening and hyperæmia; at other times there is œdema of the mucous membrane and even the formation of bullæ, and at times superficial ulcerations are observed. When the lesion involves only the mucosa and to a slight extent the submucosa, simple irrigations with silver nitrate or other silver salts, particularly if the bladder is overdistended with the irrigation at each treatment, will very promptly lead to disappearance of the infected areas. Where, however, these localized areas of cystitis involve markedly the submucosa and to a slight extent the muscle of the bladder-wall, irrigations used in the ordinary way have comparatively slight influence. For the treatment of these resistant areas of cystitis, I have been using, during the past two years, a particularly efficacious method, which is as follows: The bladder is filled with salt solution and then an ureter catheterizing cystoscope is passed and an ordinary ureter catheter without the side eye and with the end cut square is passed into the bladder. The tip of the catheter is then placed against the area to be treated and a 10 to 20 per cent silver nitrate solution injected directly on the area. In this way it is possible to secure a local application of a very strong solution, and at the same time not irritate the rest of the bladder.

The excess of silver is immediately neutralized by the salt solution and the effect of a strong application is secured on the area desired. In women by means of the Kelly cystoscope with air distention, the application of strong solutions to localized areas is, of course, readily made and the results obtained by this method have been indeed most gratifying. In the male by the method described above the same therapy is attained. In some instances where the lesion is particularly resistant, I have fused a silver nitrate point to the end of a metal-tipped ureter catheter, and it is possible in this way to paint the desired area with the silver nitrate stick it-

self. By a combination of these methods it has been possible to secure results in the past few years in a large number of cases in which the vesical lesion had resisted all of the ordinary therapeutic measures, and the relief afforded the patients was indeed most gratifying. When the lesion involves deeply the bladder muscle, nothing short of radical procedures will afford relief.

If on cystoscopic examination one finds a localized area on which the mucous membrane looks whiter than normal, with puckered or scarred condition, one can feel reasonably certain that no local applications will afford relief. If again there is present an evident mucosa lesion which seems to respond to the local applications but without improvement in the symptoms of the patient, one can be reasonably certain that there is deep involvement of the bladder-wall. It is our experience that relief of the pain, frequency, tenesmus, and strangury, which is bitterly complained of by many of these patients, can only be obtained by resection of the involved area. It is rather interesting that these areas are frequently single, although they may be multiple. They are most frequently found on the lateral walls or apex of the bladder. Because of their occurrence on the apex they are often missed, when indirect cystoscopy alone is employed. When a patient complains of frequent and painful urination whether there is present or not a pyuria, before the bladder is pronounced normal it should be investigated by both the direct and indirect forms of cystoscope.

Neither form of cystoscope alone renders visible every portion of the bladder, but by the combined examination all of the bladder can be readily explored. These cases of what might be termed "paracystitis" resist all forms of vesical treatment. They form a very interesting group of cases, often present themselves with a long-standing history of intolerable discomfort, and the urinary and cystoscopic findings are frequently out of all proportion to the symptoms of the patient. In some of these cases the urine is macroscopically clear and the most searching examination of the bladder will be necessary to localize the area which is causing the disturbance. Removal of the diseased portion of the bladder will give a most wonderful and satisfactory result, and I know of no class of patients more grateful for the relief afforded. Hunner has described these lesions as an obscure form of ulceration, and to him should be given the credit of directing our attention to a lesion of the bladder hitherto neglected and undiagnosed. In several cases where the lesions were multiple, and on the posterior bladder-wall where resection was impossible or inadvisable, great relief has been obtained by deep cauterization of the inflamed areas with the actual cautery, burning practically through the whole depth of the bladder-wall. However, where the areas are accessible, resection is to be preferred. Simple cystotomy even with long-continued drainage fails to afford any relief. In the past these patients have wandered from clinic to clinic and physician to physician without securing relief and have frequently been diagnosed as neurasthenics. The recognition that there is an underlying pathological basis for the symptoms in these patients adds another triumph to the achievements of modern urology.

THE BLADDER CHANGES DUE TO LESIONS OF THE CENTRAL NERVOUS SYSTEM

Their Description and Treatment

By J. EDWARD BURNS, M.D., Baltimore
Resident Urologist, Johns Hopkins Hospital
From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital

THE bladder picture due to lesions of the central nervous system depends primarily upon the changes in tonicity of the bladder musculature, this latter term including the fibers of the internal vesical sphincter as well as those of the bladder wall itself. These changes in tonicity of the bladder musculature are, of course, secondary to lesions in the brain, spinal cord, or peripheral nerves. As a result of these nerve lesions and the consequent secondary changes in the bladder musculature, urinary symptoms arise sooner or later according to the location of the lesion in the central nervous system.

The early occurrence of urinary symptoms in these diseases brings the patient often primarily to the urologist for relief. These symptoms if not initial often form a most pronounced feature early in the disease; particularly has this been noted in tabes dorsalis. According to Erb they are initial in 30 per cent of the cases of this disease, and Starr states that they are particularly prominent early in the disease in 80 per cent of the cases. They may, however, occur also in general paresis, lateral and multiple sclerosis, transverse myelitis, syringomyelia, and in traumatic lesions and tumors of the cord. These urinary symptoms are incontinence, hesitancy, frequency, dysuria, and retention, and occur proportionately in the order named. In reviewing the records of Hugh H. Young's cases, it is seen that incontinence is the predominant symptom in cases of tabes presenting themselves for treatment, being present in 61 per cent. This may be constant, or nocturnal or diurnal. Hesitancy occurred in 21 per cent, retention in 15 per cent and frequency in 13 per cent of the cases. The urinary symptoms may begin with hesitancy, or the patient may state that he only has to void twice in twenty-four hours, and that then he does not feel as if he empties his bladder completely.

When the bladder is contracted, frequency and dysuria are the predominant symptoms and there may be no residual urine. There may be incontinence in these cases, which is usually associated with a cystitis, the incontinence here being due to a complete relaxation of the internal sphincter and the neighboring urethral muscles. When the bladder is dilated, hesitancy and retention usually occur and incontinence, of the paradoxical or overflow type, comes on later.

As the afferent neurones of the lumbar nerves are the first to undergo degeneration in tabes, the blocking of the sensory impulses from the pelvic viscera, and especially the bladder, early in the disease is, of course, the cause of the early appearance of these urinary symptoms in such a large proportion of the cases. The innervation of the bladder is mainly through the hypogastric and sacral nerves. This fact was discovered by Budge (1), and Gianuzzi and Nawrocki (2) working in Claude Bernard's laboratory and has been confirmed by all subsequent workers. Courtade and Guyon (3), state that there are two sets of tracts: the superior, composed of communicating branches from the third, fourth, and fifth lumbar nerves connecting with the ganglia of the sympathetic, the inferior mesenteric ganglion and the hypogastrics; the inferior tracts from the second and third sacral nerves (nervus erigens of Eckhard). The bladder also receives branches from the inferior hæmorrhoidal, and prostatic plexus, continuations of the hypogastric plexus.

The reflex centers for bladder control lie in the inferior mesenteric ganglion, and the sacral segments of the cord below the lumbar enlargement, the latter being the more important. Roussy and Rossi (4), have shown that this reflex center is located in the conus

terminalis. The exact location of the cortical center for urination is unknown, but probably lies between the arm and the leg centers, the sensory fibers reaching it by way of the posterior columns of the cord.

On account of this complicated and extensive innervation of the bladder, and the location of the different reflex centers for the control of urination, it will readily be seen how frequently this function may be impaired in diseases of the central nervous system. The secondary changes taking place in the bladder wall, both structurally, and in regard to its tonicity and the diminution in the tone of the internal vesical sphincter have been demonstrated by cystoscopic and roentgenographic examinations. The roentgenographic examination of the bladder is accomplished by the introduction of some fluid medium which is opaque to the roentgen-ray. In making a cystogram, the bladder should be comfortably filled with the fluid. Formerly a suspension of bismuth subcarbonate was used for this purpose, but this was found to be extremely hard to remove and was quite irritating to the vesical mucosa. Collargol proved too expensive and often left a deposit in the bladder which was hard to remove. It was also dirty, staining everything with which it came in contact. Since the introduction of 10 per cent thorium solution (5), for use in cystography these objections have been entirely overcome.

On cystoscopic examination the bladder wall as a rule shows varying degrees of trabeculation, which is evidenced by the marked prominence and hypertrophy of certain muscle-bundles, the spaces between them being more or less depressed, and leading to the so-called cellule formation. This change in the bladder musculature was first described by Nitze, and considered by him as being quite diagnostic of disease of the central nervous system in the absence of any obstruction to the urinary outflow such as might be caused by prostatic hypertrophy, urethral stricture, or valve formation in the urethra. This fact has been elaborated upon by Boehme (6), Fronstein (7), and others. Some authors go so far as to state that the appearance of the trabeculations, and their distribution upon the bladder wall are of diagnostic significance. The etiology of such trabeculation, whether it be a trophic nerve disturbance causing the atrophy of certain muscle-bundles rendering others more prominent, or whether it be a pure hypertrophy of certain muscle-bundles has also been a matter of speculation. The bladder may be very greatly dilated, its capacity being markedly increased above normal. It may be contracted and sometimes is quite irritable, this latter fact being usually due to cystitis. The mucosa may show varying degrees of inflammation. The trigone as a rule is atrophic, the ureteral ridges and ligamentum interuretericum being much less prominent than normal. The ureteral orifices are often not seen to contract on functionating. They may, however, be normal in size and appearance, or somewhat dilated, showing a diminution in the tone of the circular fibers surrounding them. Study of the prostatic orifice shows it to be either markedly dilated or to exhibit marked diminution in its tonicity. The cystoscope, as a rule, can be drawn into the posterior urethra, and the intra-urethral portion of the lateral lobes of the prostate, and the verumontanum readily seen. This maneuver has been used in this clinic for several years in demonstrating the lack of tonicity, or dilatation of the internal vesical sphincter. The lack of tonicity of the bladder wall is best shown by the weak outflow of residual urine or any fluid introduced through a catheter for irrigation purposes. There may be no residual urine present or there may be quite large amounts.

The cystograms show by the size of the bladder shadow and its form, the degree of dilatation, and the shape of the bladder. The margins of the shadow are often quite irregular and notched, due to the presence of trabeculations. By this means the location of the distribution of the trabeculations upon the bladder wall can also be demonstrated. In some of the cases where there was marked diminution in tone of the ureteral orifice, some of the fluid has escaped into the ureter, and it was found to be dilated, another evidence of lack of tonicity of its musculature due to the same cause. When the lack of

tone of the internal sphincter is sufficient to bring about complete relaxation of this muscle, the fluid would escape into the prostatic urethra, the cystogram showing the degree of dilatation and the so-called funnel-shape of the posterior urethra. From a study of the cystograms in the cases which show the funnel-shaped posterior urethra, it is found that this could only be demonstrated when complete incontinence existed. It will be seen from these plates that there is almost complete closure in the region of the external sphincter.

This funnel-shaped posterior urethra has been demonstrated experimentally in cats by Barrington (8), after resection of the posterior sacral roots. In these animals he found that micturition was abolished after division of these roots, and that dilatation of the internal sphincter and a funnel-shaped posterior urethra could be demonstrated by filling the bladder with collargol and making a roentgenogram. I have carried out similar experiments on dogs[1] and found that after resection of the posterior sacral roots there was marked hesitancy and gradual accumulation of residual urine resulting on about the third day after operation in incontinence. On the first and second days, however, the animals could urinate at intervals which were rather prolonged and even after incontinence was established the act of urination could still be performed. Figure 1 shows the dilatation of the internal sphincter and funnel shape of the posterior urethra one week after the operation.

Uhle (9) and others have demonstrated that the internal vesical sphincter is of prime importance in bladder closure in man. The incontinence in these patients is therefore due, quite often, to dilatation of the internal vesical sphincter and urethral muscles and not an incontinence of the overflow or so-called paradoxical type.

There is a class of cases in which the cystoscopic and roentgenographic pictures are absolutely typical of disease of the central nervous system but in which no evidence of such disease can be demonstrated clinically

[1] There was a loss of control of the anal sphincter and some motor paralysis in these animals.

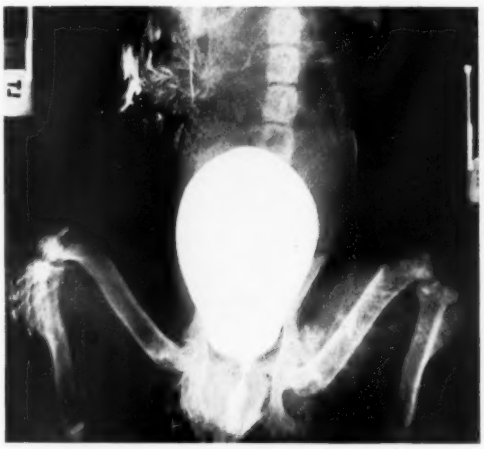


Fig. 1. Cystogram showing a dilatation of the internal sphincter and funnel-shaped posterior urethra one week after operation.

or serologically. In one of these cases which came to autopsy lately, careful serial sections of the cord from all segments failed to reveal any lesion. The only explanation possible in these cases is that the lesions occur in the ganglia or peripheral nerves and are either quiescent or are not sufficiently extensive to give rise to any clinical or serological manifestations.

The treatment of these cases is most important, and while there have been a few which have shown very little if any improvement, practically all, both clinically and serologically, have shown a very marked improvement. Even the temporary amelioration of such distressing symptoms as lightning pains and incontinence is most helpful to these patients, but in many instances, these symptoms and others have been entirely relieved, at least so far as our observations go.

The treatment may be divided into systemic and local. Under systemic treatment comes the intravenous administration of salvarsan, the administration of mercury in various ways, and the giving of iodide of potassium. If the patient's blood Wassermann is positive on admission, he is given salvarsan intravenously, three-tenths to six-tenths of a gram each week for four to five doses. Often mercurial inunctions are given at the same time,

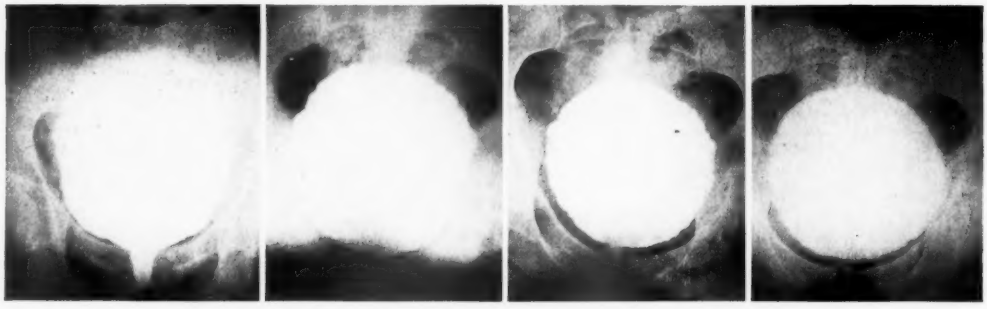


Fig. 2. Fig. 3. Fig. 4. Fig. 5.

Fig. 2. Case 1. Cystogram showing dilated bladder. Irregularities of the superior and lateral margins of shadow due to trabeculation. Dilated internal sphincter, funnel-shaped posterior urethra.

Fig. 3. Case 1. Cystogram after one intraspinous treatment of mercurialized serum and three dilatations with Kollmann dilator. Internal sphincter closed.

Fig. 4. Case 1. Cystogram after further intraspinous treatment and several dilatations with the Kollmann dilator. Internal sphincter somewhat dilated.

Fig. 5. Case 1. Cystogram after five months' treatment—five intraspinous injections of mercurialized serum, seven intravenous injections of salvarsan, numerous dilatations with Kollmann dilator, showing spherical shadow with irregular outline due to trabeculation. Internal sphincter closed.

and mercury in some form is used alone, if the salvarsan is not well tolerated. This treatment is kept up at intervals until the blood Wassermann becomes negative, and has remained so for one year after all treatment has been discontinued. Under this head will also come the intradural treatment for which either mercurialized or salvarsanized serum may be used. In this clinic we have used the former according to the method of Dr. C. M. Byrnes (10), of the Neurological Department. If the spinal fluid on admission shows a positive Wassermann, a cell count above normal, a positive globulin test (both Ross Jones and Pandy), and the gold chloride test shows either a paretic or luetic curve, from 1/50 to 1/25 of a grain of mercurialized serum is given intraspinously once a week for four to five treatments. An interval of several months is then allowed to elapse, at the end of which time another spinal fluid and blood Wassermann examination should be made, and if sufficient indications be present another series of intravenous and intradural treatments instituted. Under such treatment the first and most marked improvement consists in the gradual lessening and disappearance of the lightning pains, improvement in incontinence which in some instances has been temporary and in others apparently permanent, improvement in gait, the ataxia and muscular inco-ordination being apparently much less, and also an improvement in the patient's general condition from a nutritional standpoint has been noted in many cases. For example, a patient who complained on admission of slight nocturnal incontinence, lightning pains and ataxia, and whose blood Wassermann was negative but whose spinal fluid showed a positive Wassermann, a cell count of 85 per cubic millimeter a positive globulin test, and a gold chloride showing a paretic curve, was given five intraspinous treatments of mercurialized serum in thirty-eight days, four of which were 1/50 and one 1/25 of a grain. During this period of treatment the residual urine was decreased from 250 cubic centimeters to nothing and his gait became more steady. He voided once at night and had no nocturnal incontinence. During his stay in the hospital he was also given two dilatations with the Kollmann dilator up to 30 F. On discharge from the hospital at the end of thirty-eight days the spinal fluid examination was as follows: cell count 40 per cubic millimeter, globulin plus, Wassermann negative and the gold chloride still showed a paretic curve. Examination of this patient five months later showed a negative blood and spinal fluid Wassermann, a cell count of 8 per cubic millimeter, globu-

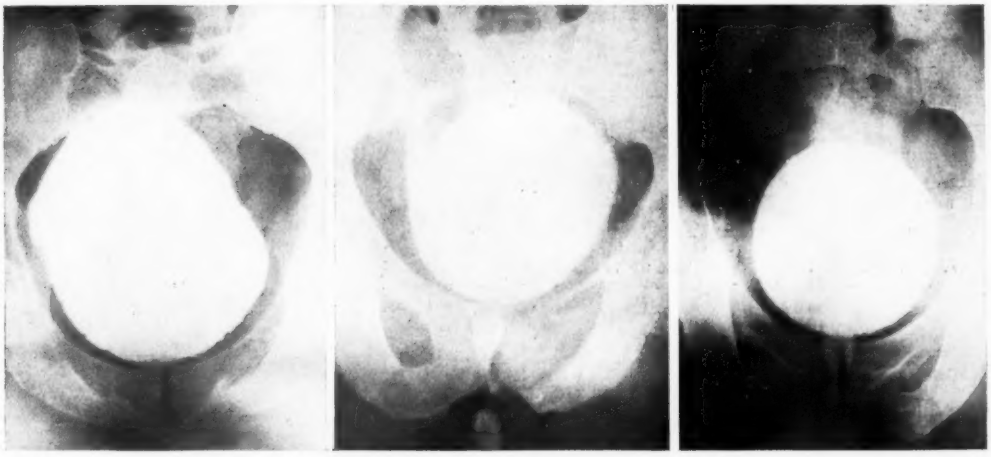


Fig. 6. Fig. 7. Fig. 8.

Fig. 6. Case 2. Cystogram showing the bladder dilated. Internal sphincter closed.

Fig. 7. Case 3. Cystogram showing a bladder shadow smaller than normal, with irregularities at superior margin due to trabeculation. Dilated internal sphincter. Funnel-shaped posterior urethra.

Fig. 8. Case 4. Cystogram showing the bladder shadow spherical in outline with margins slightly irregular due to trabeculation. Dilated internal sphincter.

lin plus (Ross Jones; Pandy ?), gold chloride negative. The pains in the legs had disappeared entirely and occasionally he was having slight nocturnal incontinence. The ataxia had improved very markedly, as had his sexual powers. The patient is to return in six months for further observation.

Under local treatment is considered the relief of incontinence, the reduction of residual urine with the consequent improvement in kidney function, which is often impaired as a result of back pressure, the same phenomenon as observed in prostatic hypertrophy or stricture of the urethra. The incontinence seems to be markedly benefited if not entirely relieved by urethral dilatation. In one case the mere passage of a cystoscope caused permanent relief of incontinence. Dilatation of the urethra with filiform and followers, sounds and the Kollmann dilator have been quite effective in many cases. Such regular dilatations in connection with intraspinous and intravenous therapy were carried out in Case 1. The dilatation should be done once or twice a week. If the residual urine be large in amount and uninfected, there should be catheterizations at regular intervals, or if the residual urine be very large and the phenolsulphonephthalein output be very low, the patient should be put to bed and continuous catheter drainage instituted. Great care should be taken to avoid infection in these cases, for on account of the lowered resistance of the patient, once introduced it often spreads very rapidly and causes, in turn, cystitis, ureteritis, pyelitis, and pyelonephritis, unless measures be instituted to check it. If infection be present, the patient should be given large doses of urotropin, boric bladder irrigations twice a day while the retention catheter is in place and frequent bladder instillations of 10 per cent argyrol. The pyelitis is best treated by lavage of the renal pelvis with silver nitrate solution.

Under this heading may also be considered the operative procedures undertaken when there is a coexistent prostatic hypertrophy. Dr. Young has performed perineal prostatectomy on several of these patients with complete relief of the urinary symptoms; where there has been a median prostatic bar he has excised this by means of the punch operation, with a similar result (11). It is in-

teresting to note that these patients did not have incontinence afterwards.

The following cases illustrate these bladder changes. In some of these cases the plan of treatment, both systemic and local, is given.

CASE 1. Tabes dorsalis. Wassermann positive (blood and spinal fluid). Incontinence of urine, with a residual urine of 120 cubic centimeters. Dilated internal sphincter. Incontinence cured by systemic treatment and urethral dilatation.

W. Z., age 49, primary syphilis at 25 years. The symptoms began four years ago with incontinence which was intermittent in character. The loss of sexual powers began two years ago. The general symptoms were slight. The blood and spinal fluid Wassermann tests were positive. The spinal fluid cell count was sixty per cubic millimeter, and the globulin test was positive. Rectal examination showed the anal sphincter to be of poor tone, and that the prostate was not enlarged. On cystoscopic examination the residual urine was found to be 120 cubic centimeters, bladder capacity 720 cubic centimeters. The bladder wall was markedly trabeculated, the trabeculations extending over the whole surface; it was also somewhat inflamed. The ureteral orifices were normal in size and appearance, and not seen to contract on functionating. The trigone was normal in appearance. The cystoscope could be drawn into the posterior urethra and the verumontanum plainly seen. With the finger in the rectum and the cystoscope in the urethra, no thickening of the median portion of the prostate or trigone was made out.

The cystogram (Fig. 2) shows a dilated bladder; there are irregularities of the superior and lateral margins of shadow due to trabeculations. The internal sphincter is markedly dilated allowing some of the bismuth suspension to escape into the prostatic urethra, and causing a funnel-shaped posterior urethra shadow. The ridges of the verumontanum can also be seen in the shadow. The external sphincter is very slightly relaxed.

The patient then received one intraspinous treatment of mercurialized serum, and three dilatations with a Kollmann dilator up to 40 F., after which the incontinence was less marked. The cystogram (Fig. 3) shows the bladder still to be dilated but more nearly spheroid in shape. The irregularity of the margins due to trabeculation is less marked; the internal sphincter is closed, no bismith suspension having escaped into the prostatic urethra.

During the following two months the patient received two intraspinous treatments of mercurialized serum and several dilatations with the Kollmann dilator. The incontinence was then intermittent, the patient stating that at times he has no incontinence for three or four days. The cystogram (Fig. 4) at this time shows a spherical shadow with irregular margins due to trabeculation. There is also some dilatation of the internal sphincter, the bismuth suspension having escaped into the posterior urethra, giving a funnel-shaped shadow.

After five months' treatment, during which time the patient had five intraspinous injections of mercurialized serum, and seven intravenous injections of salvarsan besides numerous dilatations of his urethra with a Kollmann dilator, he returned for observation saying that he had had no incontinence for seven weeks. There was slight incontinence on exertion, sneezing or coughing. His gait was markedly improved. No lightning pains nor disturbance of vision was present. Catheterization showed that he had 90 cubic centimeters residual urine and that his bladder capacity was 550 cubic centimeters. The bladder was then injected with a 10 per cent solution of thorium. The cystogram (Fig. 5) shows a spherical shadow with irregular margins due to trabeculation. The internal sphincter is tightly closed, no thorium solution having escaped into the posterior urethra. This is an excellent example of the beneficial effects that can be accomplished by thorough local and systemic treatment, the various stages of improvement being splendidly shown by the cystograms.

CASE 2. Tabes dorsalis. Wassermann (blood and spinal fluid) positive. Incontinence with a residual urine of 280 cubic centimeters. Dilated internal sphincter. Incontinence cured by dilatation of the urethra.

J. G., age 33. General symptoms had been present four months. The blood and spinal fluid Wassermanns were positive. Rectal examination showed the anal sphincter to be of poor tone; the prostate was not enlarged but was somewhat indurated and adherent.

On cystoscopic examination the residual urine was found to be 280 cubic centimeters. The bladder capacity was 580 cubic centimeters. The bladder wall was moderately trabeculated throughout. The ureteral orifices were irregular, and not seen to contract on functionating. The cystoscope could be drawn into the posterior urethra and the verumontanum plainly seen. After the first passage of the cystoscope, the incontinence stopped and there has been no recurrence. The patient's urethra has been dilated with a Kollmann dilator and he has also had intravenous and intraspinous treatment for two months.

The cystogram (Fig. 6) shows the bladder to be dilated. The bladder shadow is ovoid with irregularities around its entire margin due to trabeculations. None of the bismuth suspension has escaped into the prostatic urethra, showing complete closure of the internal sphincter, following the treatment.

CASE 3. Tabes dorsalis and progressive central muscular atrophy. Wassermann (blood and spinal fluid) positive. No residual urine. Dilated internal sphincter.

S. P., age 61. Patient had had general symptoms with difficulty of urination and incontinence for three years. The blood and spinal fluid Wassermanns were positive. The spinal fluid cell count

Fig. 9 (at left). Case 5. Cystogram showing oval shaped bladder. Margins irregular due to trabeculation. Dilated internal sphincter. Funnel-shaped posterior urethra.
Fig. 10 (at right). Case 6. Cystogram showing a pyriform shaped bladder shadow, with marked irregularity of the superior and lateral margins due to trabeculation. Dilated internal sphincter. Funnel-shaped posterior urethra.

was 82 per cubic millimeter. The gold chloride was positive in the paretic zone. The rectal examination showed the anal sphincter to be of poor tone and the prostate not enlarged.

On cystoscopic examination no residual urine was found, the bladder capacity being 300 cubic centimeters. The bladder wall was injected and trabeculated toward the vertex, and its tonicity was poor. The trigone was atrophic. The ureteral orifices were normal in appearance. No intravesical hypertrophy of the prostate was made out. The cystoscope could be drawn into the posterior urethra and the verumontanum seen. With the finger in the rectum and the cystoscope in the urethra there was no thickening of the median portion of the prostate nor trigone. The cystogram of this case (Fig. 7) shows a bladder shadow smaller than normal with irregularities at the superior margin due to trabeculation. The internal sphincter is widely dilated, the bismuth suspension having escaped into the prostatic urethra, giving a funnel-shaped shadow. The right ureteral orifice is dilated and the bismuth suspension has escaped into the right ureter, which is also seen to be dilated.

Case 4. Tabes dorsalis. Wassermann negative. Incontinence. No residual urine. Dilatation of the internal sphincter.

E. E. W., age 37. Ataxia had been present for 1½ years. For the last six weeks there has been frequency of urination and incontinence. There had been loss of sexual power for one year. The blood Wassermann was negative. Rectal examination showed the anal sphincter to be markedly atonic; the prostate and seminal vesicles were normal. On cystoscopic examination no residual urine was found; the bladder capacity was 300 cubic centimeters. There was no intravesical enlargement of the prostate. The bladder wall was distinctly trabeculated. The trigone was hypertrophied. The ureteral orifices were easily seen and apparently functioning well, the urine from either side being clear. The cystoscope could be drawn to the posterior urethra and the verumontanum readily seen. The cystogram (Fig. 8) shows the bladder shadow to be spherical in outline, its margins being slightly irregular, due to the presence of trabeculation. The internal sphincter is dilated, as is the external sphincter, the thorium solution having escaped into the posterior, and also into the bulbous urethra. In this instance constriction had to be applied to the urethra after the catheter was removed in order to retain the thorium solution. The posterior urethra shows a tendency to become funnel-shaped.

Case 5. Tabes dorsalis. Incontinence. Residual urine 800 cubic centimeters. Dilatation of internal sphincter.

R. H. H. The present illness began five years ago with frequency and urgency of urination. The patient had had incontinence for three years. There had been loss of sexual powers for the past twelve years. On rectal examination the anal sphincter was found to be of good tone. The prostate was moderately hypertrophied. On cystoscopic examination the residual urine was found to be 800 cubic centimeters, and only 400 cubic centimeters could be reintroduced into the bladder without causing the patient much discomfort. The prostate was found to be enlarged intravesically, the enlargement being mainly in the left lateral lobe and to some extent in the median portion. The bladder wall was

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 11. Case 7. Cystogram showing pyriform shaped bladder shadow, with irregular margins due to trabeculation. Slight dilatation of internal sphincter.

Fig. 12. Case 8. Cysto-ureterogram showing pyriform shaped bladder shadow. Dilated internal sphincter and ureteral orifices. Funnel-shaped posterior urethra.

Fig. 13. Case 9. Cystogram showing an enormously dilated bladder ovoid in shape. Slight irregularity of margin of shadow superiorly and on the left lateral wall due to trabeculation. Internal sphincter closed.

markedly trabeculated on the posterior and lateral walls. The trigone was hyperæmic, and somewhat hypertrophied. The ureteral orifices could not be made out definitely on account of the œdema of the trigone. The cystoscope could be drawn into the posterior urethra, but on account of cloudiness the verumontanum could not be seen. The cystogram (Fig. 9) shows the bladder shadow to be oval in shape, the long diameter being directed from above downward. Throughout the whole extent the margin is irregular, due to trabeculation. There is a dilatation of the internal sphincter, some of the thorium solution having escaped into the posterior urethra, giving a funnel-shaped shadow.

CASE 6. Tabes dorsalis. Wassermann (blood and spinal fluid) negative. Incontinence. Residual urine 450 cubic centimeters. Dilatation of the internal sphincter. Lightning pains relieved by systemic treatment.

J. H. G., age 62. The onset was fifteen years ago with hesitancy and a feeling of inability to empty his bladder completely at each urination. For the past twelve years incontinence had been constant. General symptoms began about this time. The patient has lost his sexual powers completely for the last four years. There was a history of lues thirty-two years ago. Blood Wassermann was negative; spinal fluid Wassermann also negative, cell count four, globulin negative and gold chloride negative. Rectal examination showed the anal sphincter to be of poor tone, prostate and seminal vesicles normal. On cystoscopic examination 450 cubic centimeters of residual urine was found; bladder capacity 450 cubic centimeters. There was no intravesical hypertrophy of the prostate. On account of the marked dilatation of the internal sphincter some enlargement of the right lateral lobe intra-urethrally could be made out, and the orifice of a diverticulum was seen on the left lateral wall. The cystoscope could be drawn into the posterior urethra and the verumontanum could be seen. The bladder wall was markedly trabeculated laterally and posteriorly. The trigone was atrophic. The cystogram (Fig. 10) shows a bladder shadow, pyriform in shape, with marked irregularity of the superior and lateral margin due to trabeculation. There is a diverticulum present on the lower left lateral wall. The internal sphincter is dilated, some of the thorium solution having escaped into the posterior urethra. This patient had a marked suppurative pyelonephritis and cystitis, and after each urethral dilatation had such a marked reaction that they had to be discontinued. Although from the serological examination it would seem that the disease process was quiescent, he was given intraspinous therapy with the hope of relieving the lightning pains. This was accomplished, but no improvement as regards the incontinence was noted.

CASE 7. Cerebrospinal lues. Wassermann negative. Residual urine 135 cubic centimeters. Dilatation of the internal sphincter and left ureteral orifice.

W. C., age 55. The onset of the present illness was fifteen years ago with hesitancy and frequency of urination. There had been burning on urination for the last five years. For the last six months, on account of the residual urine, the patient had been catheterized daily. There was a history of syphilis thirty-one years ago after which the patient had thorough systemic treatment. The blood Wassermann was negative. On rectal examination the anal sphincter was found to be of fair tone; a slight grade of prostatitis and seminal vesiculitis was found to be present. On cystoscopic examination the residual urine was found to be 135 cubic centimeters and the bladder capacity 225 cubic centimeters. There was no intravesical enlargement of the prostate, the bladder wall was markedly trabeculated, the trabeculation being general; the trigone was somewhat hypertrophied. With the finger in the rectum and the cystoscope in the urethra, there was less tissue felt than normally in the region of the median portion of the prostate.

The cystogram (Fig. 11) shows a bladder shadow which is pyriform in shape. There are irregularities surrounding the whole margin due to trabeculation, particularly marked on the superior and lateral margins. There is a slight degree of dilatation of the internal sphincter, some of the thorium solution having escaped into the posterior urethra, which shows a tendency to become funnel-shaped. The left ureteral orifice is evidently dilated, the thorium solution having escaped into the ureter, which is also somewhat dilated.

CASE 8. Paraplegia. Wassermann (blood and spinal fluid) negative. Incontinence. Residual urine 175 cubic centimeters. Dilatation of internal sphincter and ureteral orifices.

E. G., age 42. Paraplegia due to a fracture of the lumbar spine. After the injury ten years ago, the patient had complete paraplegia with incontinence of urine and fæces, which conditions persisted up to the present time. The blood and spinal fluid Wassermanns were negative. Rectal examination showed that there was occasional spasmodic contraction of the anal sphincter. The prostate and seminal vesicles were normal.

On cystoscopic examination 175 cubic centimeters residual urine was found. Study of the prostatic orifice showed it to be slightly irregular and œdematous. The bladder-wall was trabeculated anteriorly and on its right lateral and posterior surfaces. The trigone was thickened, the ligamentum interuretericum was hypertrophied and slightly elevated. At either corner of the trigone, there was a shallow pouch or beginning diverticulum, at the bottom of which on each side was situated the ureteral orifice. When the ureter functionated the orifice was seen to contract and rise from this shallow diverticulum, immediately receding upon the cessation of the contraction. The cystoscope could be drawn into the posterior urethra and the verumontanum could be seen.

The cysto-ureterogram (Fig. 12) shows the bladder shadow to be somewhat pyriform in outline. The thorium solution has escaped into the ureters due to the dilatation of the ureteral orifices. The margin of the bladder shadow is markedly irregular, due to trabeculation. The internal sphincter is dilated, some of the thorium solution having escaped into the prostatic urethra giving a funnel-shaped shadow. The shadows of the ureters show them to be markedly dilated, and there is also a kinking of the right ureter.

CASE 9. General paresis. Wassermann (blood and spinal fluid) positive. Hesitancy and frequency. Residual urine 1550 cubic centimeters. Diminution in tone but not complete relaxation of internal sphincter.

C. L., age 33. This patient had had general symptoms for two years. He had had hesitancy and frequency of urination for the past six weeks. The blood and spinal fluid Wassermanns were positive. The globulin tests were positive. The spinal fluid cell count was 26 per cubic millimeter. The rectal examination showed the anal sphincter to be of good tone. The prostate was not enlarged.

On cystoscopic examination 1550 cubic centimeters residual urine was found. The bladder wall showed slight trabeculation at the vertex and in the region of the ureteral orifices. The trigone was atrophic, the ureteral ridges were less prominent than usual. The ureteral orifices were sunker and did not contract on functionating. The prostate was not intravesically hypertrophied. The tonicity of the internal sphincter was impaired. The cystoscope could be drawn into the posterior urethra and the verumontanum plainly seen. No thickening of the median portion of the prostate or trigone was made out.

The cystogram (Fig. 13) shows an enormously dilated bladder which is ovoid in shape. There is slight irregularity of the margin of the shadow superiorly and on the left lateral wall due to trabeculation. The internal sphincter is closed, no bismuth suspension having escaped into the posterior urethra.

This case shows that an enormous dilatation of the bladder can take place without incontinence and relaxation of the internal sphincter.

SUMMARY

The chief changes in the bladder due to lesions of the central nervous system consist in diminution in the tone of its musculature and that of the internal vesical sphincter. As a result of such loss of tonicity, there is often a gradual accumulation of residual urine and in some instances a dilatation of the bladder. Incontinence occurs in a large majority of

the cases. Where this exists there is a dilatation of the internal vesical sphincter and a funnel-shaped posterior urethra which is readily demonstrated cystoscopically and radiographically. The incontinence may be a true paradoxical incontinence due to the gradual accumulation of residual urine and overdistention of the bladder, or it may be due directly to a relaxation of the internal vesical sphincter and the neighboring urethral muscles. In this latter type there is usually no residual urine present. The trabeculation of the bladder wall, although generally present, seems to be rather inconstant in its distribution. The trigone is usually found to be atrophic. The cystoscope as a rule can be drawn into the posterior urethra and the verumontanum and intra-urethral portions of the lateral lobes of the prostate easily seen.

The most effectual form of treatment in these cases consists of intravenous and intraspinous therapy combined with dilatations of the urethra. This has been carried out in 21 cases, when the lesion of the central nervous system was due to syphilis. Incontinence occurred in twelve of the cases; in 5 there was entire relief, in 6 marked improvement, and 1 remained the same. There was difficulty of urination in 7 cases, which cleared up entirely in 5 and was markedly improved in 2. Frequency of urination occurred in 5 cases, being entirely relieved in 3 and made much better in 2. In 10 of the cases lightning pains formed the predominant symptom; under treatment, this disappeared entirely in 7, 2 were markedly benefited, and 1 showed no improvement. Of the 6 cases having marked ataxia, 3 showed some improvement and 3 remained the same.

Of the 21 cases, 16 gave a history of previous syphilitic infection, 7 had a positive blood Wassermann on admission and in 14 the blood Wassermann was negative. The spinal fluid Wassermann was positive in 20 of the cases on admission, and in 9 is negative at the present time. There has been a decrease in cell count in 8 cases. In 9 cases the globulin has remained positive; in 4 it has become negative; in 3 it is doubtful. (Both Ross-Jones and Pandy tests were used.) The gold chloride changed from a luetic curve to a negative one in 5 cases; from a paretic curve to a negative one in 1 case; remained the same in 8 cases; changed from a luetic to a paretic curve in one instance and from a paretic to a luetic in another and was not done in 4 cases.

Nineteen of the cases had intraspinous treatment, in 7 of these it was combined with intravenous therapy and in 8 with dilatations of the urethra. In 1 case intravenous treatment alone was given.

From these observations it is seen that the majority of these patients have been benefited very markedly, if not entirely relieved, by this form of treatment, the improvement in many instances being not only shown clinically but also serologically.

I wish to thank Dr. Hugh H. Young, Clinical Professor of Urology, for having suggested this study, and Dr. C. A. Waters, of the Department of Roentgenology, for his valuable assistance in the radiographic work.

I desire also to express my appreciation to Dr. H. M. Thomas, Clinical Professor of Neurology, Dr. Adolph Meyer, Professor of Psychiatry and Dr. T. C. Janeway, Professor of Medicine, for their kindnesses in placing additional clinical material for this study at my disposal.

BIBLIOGRAPHY

1. Budge. Ueber das Centrum genitospinale des N. sympatheticus. Arch. f. path. Anat., 1858, xv, 115.
2. Gianuzzi and Nawrocki. De l'influence des nerfs sur les sphincters de la vessie et de l'anus. Arch. gen. de. méd., 1863, ii., p. 170.
3. Courtade, D., and Guyon, J. F. Contribution á l'etude de l'inneration motrice de la vessie Arch. d. physiol. norm. et path., Par., 1896, viii, p. 622.
4. Roussy G., and Rossi, I. Troubles de la miction et de la defecation. Arch. de méd. exp. et d'anato. path., 1910, xxii, 199.
5. Boehme, F. Die Balkenblase als Fruehsymptom bei Tabes Dorsalis. Muenchen. med. Wchnschr., 1908, lv, 2610.
6. Fronstein, R. M. Die Balkenblase als Fruehsymptom bei Tabes dorsalis. Ztschr. f. Urol., 1910, iv, 497.
7. Burns, J. E. Thorium—a new agent for pyelography; preliminary report. J. Am. M. Ass., 1915, lxiv, 2126.
8. Barrington, F. J. F. The nervous mechanism of micturition. Quart. J. Exp. Physiol., Lond., 1914, viii, 33.
9. Uhle, A. A. Observations upon the mechanism of bladder closure. Tr. Am. Ass. Genito-Urin. Surg., viii, 303.
10. Byrnes, C. M. The intradural administration of mercurialized serum in the treatment of cerebrospinal syphilis. J. Am. M. Ass., 1914, lxiii, 2182.
11. Young. The ultimate results of prostatectomy. Tr. L'ass. internat. d. Urol., Lond., 1912, pp. 33-36.

EARLY DIAGNOSIS OF RENAL TUMOR

With the Report of 5 Cases and the Demonstration of Several Pyelograms Illustrative of the Difficulty[1]

By FRANK HINMAN, M.D., San Francisco
Instructor in Urology, University of California Medical School; Urologist, University Hospital

THE effort in every cancer problem is to make a diagnosis early enough to offer an opportunity of clean, complete removal. The application of this principle in the treatment of breast and uterine cancer has resulted in a creditable increase of cures. These diseases give early symptomatic manifestations and, as a result of wide educational propaganda, women realize the danger of delay and come for diagnosis and treatment at the onset of the symptoms. The fact that the first metastases occur along the lymphatics still gives those who fail to come in the precancerous stage the chance of cure by radical removal of the tumor and this primary lymph-zone. In malignant disease of the kidney, conditions are different. Clinical manifestations are very erratic. No precancerous or early symptoms are known. Death may result without any clinical evidence of renal involvement. Seventy-two per cent of the cases of A. O. J. Kelley's (1) pathologic study (1895), came to autopsy undiagnosed, and yet, all but 2 of these had advanced lung or liver metastasis. Kroenlein (2), ten years ago, confessed his inability, because of insufficient signs or symptoms, to make an early diagnosis in even 1 of his 20 cases. Another contrast is in the mode of metastasis. The lymphatic route is one of the least frequented. Long before the primary renal lymph-zones along the aorta have become involved, the renal vein may have carried tumor-cells to the lungs, liver, bones, or any part of the body. Implantations into neighboring organs in the peritoneal cavity or along the urinary tract (Barney, 3; Swan, 4; Garceau, 5), may have occurred.[2] Any such mode of extension nullifies the value of wide lymphatic dissections, as enthusiastically advocated ten years ago by Gregoire (6). Surgeons cannot cure renal tumor in the face of generalized metastases, and, so long as surgery remains the only cure, improvement in the late surgical results will depend upon an accurate diagnosis before metastasis more than upon any radical operative technique after.[3] A glance at the mortality reports (Table I) will emphasize the difficulty in making an early diagnosis. The average of four observers gives a five year cure of only 8.2 per cent, a mortality of over 90 per cent. Moreover, a five year time-limit for cure does not give the true mortality. Many cases have died of metastasis more than six years after operation. Kroenlein reports a case which lived twelve years after operation before death from metastasis. A comparison with the results in the treatment of cancer, in which early diagnosis and radical surgery are possible, is striking. Judd reports a five year cure in 39.8 per cent for cancer of the breast, and Wertheim, 42.4 per cent for cancer of the uterus.

The various histological forms of malignant tumors of the kidney parenchyma do not, as a rule, permit of clinical differentiation. Furthermore, tumors of the kidney pelvis, perireneal tumors and cystic formations of the kidney[4] may give similar clinical and urological pictures. There are a few facts of differentiation between the four groups: perenchymal, perirenal, pelvic and cystic. The present consideration of early diagnosis will be confined to malignant tumors of the kidney parenchyma in the adult. Of Kuester's (7) 307 cases, 261, or 70 per cent were parenchymal tumors; hypernephroma, about 70 per cent, sarcoma and carcinoma about 20 per cent, and the remainder, adenoma and

[2] Kuester's (7) analysis of 418 cases of metastasis shows the lymphatic glands involved only 68 times, or in 13.8 per cent; lungs, 92; liver, 77; second kidney, 42; bones, 23; pleura, 22; abdominal wall, 19; suprarenal, 14; brain, 10; bladder, 6, etc.
Garceau in an analysis of 176 cases of hypernephroma found bone metastasis most frequently, with lung next and regional glands third.

[3] It is not intended to condemn the radical operations (Gregoire). Every kidney tumor should be removed, if possible, inside its perirenal capsule (Gerota, Zuckerkandl), and all regional glands should be cleanly removed.

[4] Pelvic: papilloma, papillary epithelioma, carcinoma, sarcoma. Perirenal: (tumors of kidney capsules) mixed, sarcoma, lipoma, fibroma, myxoma. Cystic: dermoid, retention, serous, polycystic.

[1] Read in the "Symposium on Tumors of the Kidney," at the Meeting of the California State Medical Society, April 19, 1916.

TABLE I

Author	Year	No. of Cases	Hypernephroma	Hæmaturia				Tumor				Pain			Cachexia		Complete Hæmaturia Tumor Pain	Hæmaturia and Tumor	Pain and Tumor	Hæmaturia and Pain	Results of Nephrectomy			
				Initial	Only	Observed	Found on Exam.	Initial	Only	Observed by patient	Found on Exam.	Initial	Only	Observed by patient	Initial	Late					Operative Mortality	Year Cure		
																						2	3	4	5
Average	.....	.....	.....	42%	6.6%	.....	.....	18.5%	8.1%	.....	84	32%	14%	79	.....	.....	38%	.....	.....	.....	.....	.....	.....	.....	.....
Willan (12)	1015	52	.....	27	2	.....	.....	20	11	.....	87	36	.....	85	9	.....	60	9	6	11	.....	.....	.....	.....	.....
Barney (3)	1913	74	37	24	4	52	.....	20	6	62	78	33	13	85	.....	54	.....	22	30	20	.....	.....	.....	.....	.....
Braasch (19)	1913	83	.....	36	12	64	40	15	6	34	78	32	17	82	.....	.....	38	.....	.....	.....	11	27	.....	10	
Pleschner (15)	1913	80	80	30.6	.....	67.5	78	8.7	.....	.....	77.6	8.7	.....	.....	.....	.....	22	.....	.....	.....	31.2	31	17	9.6	4.8
Hartmann (21)	1912	18	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11	*			
Squier (13)	1909	24	6	.....	.....	47	.....	.....	.....	.....	80	.....	.....	55	20	70	32	.....	.....	.....	50				
Albrecht (9)	1905	34	28	21.4	.....	.....	39.3	.....	.....	.....	80	25	.....	41.6	.....	.....	.....	.....	12	.....	.....	8			
Kronlein (2)	1905	20	9	†	.....	80	.....	.....	.....	.....	.....	.....	.....	.....	15	.....	.....	.....	.....	.....	5				
Imbert (22)	1903	257		54	.....	68	.....	20	.....	.....	84	35	.....	45	.....	.....	.....	.....	.....	.....	.....	13			
Hypernephroma a nd carc inoma				75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....				
Sarcoma and aden oma				45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....				
Kuester (7)	1902	261	.....	.....	.....	.....	‡15.8	.....	.....	.....	(100)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30	22	11	9
	1890			.....	.....	.....	52	.....	.....	.....	60	.....	.....	43	.....	.....	.....	.....	.....	.....	.....				
Heresco	to	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19.3	.....	.....	.....	.....
	1905			.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Israel (8)	1894	56	.....	70	.....	.....	92.1	.....	.....	.....	.....	.....	.....	15	.....	.....	.....	.....	.....	.....	18.6	.....	.....	.....	.....
	Before																								
Guillet	1890	65		26	.....	60	.....	26	.....	.....	.....	30	.....	80	.....	.....	.....	.....	.....	.....	60	.....	.....	.....	.....
		In 29 children		19%				67%																	

*4 living. 13 dead; time not stated. †Mehrzahl. ‡Under 10.

embryoma. About 6 per cent of all renal tumors are benign (Keen).

The diagnostic problem contains three parts for consideration: the clinical symptoms and signs, the findings of an urological examination, and the correlation of the clinical and the urological findings. The signs and symptoms remain, as formerly, the principal factor in the diagnosis but are rarely pathognomonic. The urological findings, unless verified by clinical facts, cannot in themselves make a positive diagnosis. Their greatest value is in differential diagnosis and in the identification of clinical facts. The correlation of all clinical and urological evidence may make a positive diagnosis and will at least give the foundation of safety otherwise impossible.

Clinical evidence. About one-third of the cases reported in the literature (see Table I) have had, when they came to operation, all three of the so-called cardinal symptoms of renal tumor: hæmaturia, pain, and tumor. It would be interesting to know the late results of nephrectomy in this group with complete symptoms, as compared to that in which only one of the triad was present. Diagnosis based upon complete symptoms cannot be considered an early diagnosis. An early diagnosis implies one which precedes metastasis, of which the duration or completeness of symptoms is a very unreliable index.[1] Cases are on record with symptoms ten to fifteen years before that have remained well after operation. Cases with symptoms of a few months' duration at the time of operation have died of metastasis, and other cases have been known to succumb with kidney carcinomatosis without having had any of the classical symptoms. Case 5 died seven months after the first and only attack of hæmaturia. In general the probability of the onset of metastasis increases with the duration of symptoms. Identification of symptoms in the very beginning will constitute, therefore, in the light of our present knowledge, an early diagnosis.

An analysis of the records of several reliable observers is given in Table I. Hæmaturia

[1] Carcinoma and sarcoma metastasize more rapidly than hypernephroma.

varies as an initial symptom, from 70 per cent in Israel's (8) 66 cases, to 21.4 per cent in the 32 cases of Albrecht (9), and gives an average incidence, as the onset symptom, of 42 per cent, or in 301 of the total of 709 cases of eight different surgeons. Pain is the initial symptom in 204 of 643 cases, or 32 per cent; and tumor is the initial symptom in 113 of 611 cases, or 18.5 per cent. It is the exception for a case to come to operation before it has developed more than one of these symptoms. Hæmaturia remained the only symptom in 14 of 209 cases, or 6.6 per cent; pain, in 24 of 157, or 14 per cent; and tumor in 17 of 209, or 8.1 per cent These facts indicate the lost opportunity in making an early diagnosis. At the time of operation, presumably of diagnosis also, less than 10 per cent had one symptom only, while in 42 per cent hæmaturia had been the initial symptom, in 32 per cent, pain, and in 18.5 per cent tumor. More than one symptom is uncommon at the onset. Pain and tumor were noted first in only six of Barney's 74 cases, pain and hæmaturia in six also, and hæmaturia and tumor in only one case. According to Hendon (10), 90 per cent of hypernephroma cases show hæmaturia before the tumor can be palpated, and he cites a case with ureteral coagula appearing some ten years before the tumor. Denaclara (11) notes the significant observation that in only one of 146 cases of hæmaturia in renal neoplasm (409 case reports analyzed) did the attack last as long as 14 days, a fact of some clinical importance in differentiating other hæmaturias.

The accurate identification of initial symptoms is difficult. The two most frequent of these, hæmaturia and pain, are common occurrences from other causes. Furthermore, a surprisingly large number of cases have their first intimation of trouble through gradually developing weakness and loss of weight, clearly an initial symptom which promises little for early diagnosis. Nine per cent of Willan's (12), 20 per cent of Squier's (13), and 15 per cent of Kroenlein's (2) cases had cachexia as the onset symptom. Metastasis, vomiting (as in Case 1), varicocele or a caput medusæ, swelling of the legs or even uræmia (Weber, 14) may be the first disturbance. Nevertheless, an early identification of hæmaturia, of abdominal and lumbar pain, and of abdominal tumor, which are more likely to be early, remains the logical solution of the problem of early diagnosis. An urological examination is here invaluable.

Urological evidence. The catheterization of ureters and a report of the findings of the two separate urines does not constitute an urological examination. Such an abbreviated examination, a request for which almost every urologist has experienced, will almost invariably fail in furnishing the facts of differentiation which are its chief value. Three precystoscopic procedures are of vital importance to a satisfactory study: complete urinary findings; X-ray exploration of kidneys, ureters, and the bladder; and, an estimation of total renal function. The urine for examination should be bladder urine free of contamination and may be obtained by having the patient void in three sterile glasses, the third glass being used; or better, particularly in women or where cultures are to be made, by catheterization of the bladder. The determination of macroscopic or microscopic blood before any form of urethral instrumentation bears a considerable value. Albumin, pus, casts, or blood were found in 61 of Barney's 74 and in 39 of Pleschner's (15) 41 cases. Ten only of the 74 had normal urines. The amount and character of pus and the absence or presence, and their type, of organisms, has precystoscopic significance. Sterile pus signifies tuberculosis in the majority of cases, but may accompany stone, gonorrhœa, or tumor necrosis.

The X-ray exploration is seldom of much value in identification of tumor unless associated with pyelography. But plain skiagrams may show shadows in the kidney region or line of the ureter, in order to identify which, particular procedures will be used in the cystoscopic examination which otherwise might be neglected. The finding of stone in the kidney does not eliminate the possibility of tumor. Noguira (16) reports a hypernephroma associated with a stone weighing 400 grams. Coryell (17) has emphasized stone as an etiologic factor, finding 9 of 14 consecutive cancer cases at the Mayo Clinic

associated with stone, illustrative of changes, through inflammatory irritation to hyperplastic, and hyperplastic to neoplastic. In Case 3, on the contrary, stones were shown by X-ray on the opposite side, and a very much injured kidney containing multiple stones with a unipolar sarcoma of the other kidney found after death from uræmia. The X-ray may show differences in size of kidney shadows and has a considerable value in locating bone and lung metastasis.

The estimation of total renal function has a two-fold value. It may indicate a bilateral lesion, and will control possible errors due to inhibition of function at the time of the separate functional study of the two kidneys. For this estimation phenolsulphonephthalein is incomparable. It is the only test which gives absolute values. In certain cases one of the retention tests, such as blood urea or blood nitrogen, will add additional information of total renal capacity. The total functional estimation performed precystoscopically acts as a control of inhibition, which not infrequently occurs upon ureteral catheterization, by indicating what the half-hour output of the two kidneys should be. Any figure below this, in conjunction with a knowledge of the continued patency of the catheters and relative flow on each side, particularly if there has been no leakage about either catheter, will influence the interpretation of the findings.

The cystoscopic examination should be undertaken with the object of obtaining complete information. All possible causes for the signs or symptoms must be tested. The conduct of the examination will depend on the indication of precystoscopic findings and of facts picked up as the examination proceeds. A complete kidney examination, preceded as just stated, comprises the following steps:

1. The determination of the amount of bladder residual and bladder capacity.

2. The inspection of bladder, of bladder neck, and of both ureteral orifices.

3. The collection of separate urines without trauma, for the determination of the presence of renal or ureteral blood.

4. The passage of wax-tipped catheters.

5. The ureteral catheterization, including:

A. Collection of separate specimens for chemical, microscopic and bacteriologic examination and for animal inoculation.

B. Measurement of the capacity of the two kidney pelves and the identification in character and location of the renal pain produced upon overdistention of the renal pelvis with the clinical pain which the patient has experienced.

C. Separate functional study with phenolsulphonephthalein, given intravenously and controlled for inhibition of function and for catheter leakage.

6. Ureteropyelography.

It will not be possible or necessary to analyze each of these steps. The nature of the information to be gained by each one is evident. It is possible to do each in the order outlined through the one cystoscope at the one and the same examination. If the rubber sheath and wax-tipped catheters are previously prepared very little more time is added to the ordinary ureteral catheterization, and the need of a second examination, which some patients refuse, may be avoided.

The third step, so far as known, is new. No technique, for use in the male, has ever been described for obtaining urine from the separate ureters without trauma and the resultant presence of red blood-cells. Kelley has noted the value of this procedure in connection with the use, in the female, of his open-air endoscope, the end of which may be placed over the ureteral orifice and the urine collected through it uncontaminated with the bladder contents and without trauma to the ureter or its orifice. In those cases where there is slight bleeding from one kidney, the source of the blood cannot always be determined by inspection of the ureteral orifice and this determination is frequently difficult, even when bleeding is profuse. The insertion of a catheter into the ureter almost invariably sets up bleeding which may be considerable. The presence of blood, therefore, after ureteral catheterization has no diagnostic significance. To eliminate this difficulty and error, the following procedure has been used several times recently with success: A rubber sheath, longer, but otherwise similar to that used for

the passage of a wax-tipped catheter (18), is used through the operating telescope (Brown-Burger). Inside of the rubber sheath a ureteral catheter, which tightly fills it, is inserted to within a few millimeters of the end, and this catheter is in turn plugged with a wire stylet. After passing the cystoscope and observing the ureteral orifice, if there is doubt of renal hæmorrhage and red blood-cells have been previously found in the bladder urine, the rubber sheath, plugged with the catheter and stylet, may be inserted and its inner end accurately placed over the ureteral orifice (Fig. 1). An assistant then removes the stylet. That the sheath is properly placed over the ureter must be continuously observed through the instrument and will also be shown by the intermittent flow from it. After collecting one or more specimens on a slide for immediate examination, or in a test tube, the sheath is raised from the ureter and a specimen of the irrigating fluid collected for comparison and control. The procedure, of course, is not indicated in the cases either of negative bladder urine or of cystoscopic identification of renal bleeding.

The urological facts indicative of tumor, which the several steps of the above examination may disclose, are:

Source of hæmaturia as renal; reproduction of the pain observed clinically; demonstration of disturbance in function; demonstration, by pyelography, of deformity of the renal pelvis and identification of the tumor mass with the pyelogram. Calculus, tuberculosis, hydronephrosis, many congenital renal malformations and so-called essential hæmaturia may give bleeding without infection, as usually occurs with tumor. Furthermore, too much reliance upon the identification of small amounts of blood is unwarranted. It may come from the opposite healthy but congested hypertrophied kidney (Rovsing). Practically all of the infectious diseases may be associated with hæmorrhage. Renal pain is dual in character, the excruciating renal colic which radiates and the dull or sharp, more continuous fixed ache. Movable kidney, ureteral kinks, idiopathic nephralgia from capsular adhesions or contractions, etc., extrarenal or extra-ureteral compressions in addition to all of the other renal diseases may cause abdominal pain. Disturbances in the gall-bladder, stomach, intestines, appendix, pelvis, and other organs give referred pains which may simulate renal pain. Appendectomy is a common treatment for nephroptosis. Unfortunately, for diagnosis, pain is not always referred to the affected kidney.[1] In a recent personal case the patient's only complaint was of pain on the opposite healthy side, and, peculiarly likewise, overdistention of the pelvis of the diseased kidney reproduced this pain on the healthy side. Marked overdistention caused a late colic on the diseased side, never before experienced. Overdistention of the healthy pelvis produced pain confusingly indistinguishable from that suffered. Reproduction of pain upon overdistention must, therefore, be analyzed critically.

Reduction of function, bilateral or unilateral, occurs with many different conditions. The value of a functional study in any case is empirical and proportional to the care and accuracy used in its execution and control. However, 39 of the 80 cases of tumor analyzed by Pleschner had separate functional study and all 39 showed a loss of function on the affected side. Deformities of the renal pelvis are difficult of interpretation. Certain errors in technique, as partial distention uneven dilution with pelvic residual, etc., extrarenal compression or temporary pelvic spasms and contractions (Case 15), and many other causes, may produce distortions of the pelvic outline which simulate tumor deformity. Errors in the identification of the tumor found on examination with the position of the pyelogram may arise from overlying or closely associated tumor compressing the kidney, but being unrelated (Case 14). In consequence, each urological fact must in turn be analyzed with reference to other causes than tumor. If all other causes than tumor for the signs and symptoms prove negative clinically, and, if all other causes than tumor for the facts picked up by urological examination have been excluded, a diagnosis may then be made. Completely negative urological findings will go far to discredit rather positive clinical ones,

[1] In 6 per cent of Braasch's 251 stone cases, pain was referred to the healthy side.

so that a careful analysis of complete clinical and urological facts is essential.

The correlation of the combined findings pertains to four clinical groups of cases:

1. Cases with complete classical signs and symptoms, which would alone render the diagnosis reasonably safe.

2. Cases with hæmaturia alone; with abdominal pain alone, or with hæmaturia and abdominal pain.

3. Cases with abdominal tumor the prominent sign.

4. Cases clinically indefinite, in which the urological findings are suggestive.

Five cases of tumor which have been seen in the last two years illustrate some of the above points in diagnosis. With one exception (Case 5), they all fall in group 1, cases with complete symptoms. A diagnosis in such a late stage is not an early diagnosis. None of these 5 cases are cured; 3 are dead; 2 living, inoperable. It is not possible, therefore, to illustrate with these cases the advantages of a clinical and urological correlation as advocated in the substance of the paper for early diagnosis of renal tumor. Other conditions in which the questions of kidney tumor arose are briefly outlined by way of illustrating the value of such a complete correlation. These other cases are of particular interest relative to the interpretation of their respective pelvic outlines; inasmuch as pelvic deformity is the most positive urological evidence of tumor.

GROUP I. COMPLETE SYMPTOMS

CASE 1. No. 8766, U. C. H., male, age 50. Onset five to six years ago with morning vomiting which has persisted more or less irregularly up to the present. Two years ago had an attack of pain in the lower abdomen which was dull in character and disappeared completely after two or three weeks. Six months ago he noticed that the hands were swollen and somewhat painful. Four months ago pain in the lower abdomen recurred and radiated to the back. The first attack of hæmaturia was two weeks ago. In the last two months he has lost forty-three pounds in weight. Examination reveals a large tumor in the right lumbar region. Clinical diagnosis of hypernephroma of the kidney was made and at operation a large inoperable tumor of the right kidney found. Autopsy showed a sarcoma of the upper half of the right kidney with metastasis to the liver, pancreas, and retroperitoneal and mediastinal lymph-glands.

NOTE — This report illustrates the great difficulty in early diagnosis because of the absence of leading symptoms. Periodic vomiting or indefinite pain in the lower abdomen would not put the kidney under suspicion and the symptoms which would, such as pain in the back and hæmaturia, only appeared after the tumor was palpable and inoperable.

CASE 2. No. 9261, U. C. H., female, age 60. Onset three years ago with sense of fullness and discomfort in the right lumbar region. At this time the mass was palpable and has gradually increased in size with an increase in frequency and severity of abdominal cramps and a gradually developing weakness and emaciation. Six months ago first noticed blood in the urine, which at the time was quite profuse and lasted about fourteen days. There has been no bleeding since.

Urological examination, April, 1916. Plain X-ray negative. Urine: a few leukocytes, a few red blood-cells, no casts, no organisms, trace of albumin, no sugar. Specific gravity, 1018. Total phthalein test intralumbar, 45 per cent in two hours and ten minutes.

Cystoscopy. Bladder, negative. Urine collected from the right ureter through rubber sheath shows few red blood-cells and an occasional white blood-corpuscle, that from the left, negative.

Ureteral catheterization, right. A few polymorphonuclear leukocytes, a few epithelial cells, no casts, many red blood-corpuscles, no organisms.

Left. No pus, a few epithelial cells and a few red blood-corpuscles.

Pelvic capacity, right, 12 cubic centimeters (reproduced pain in right lumbar region); left, 8 cubic centimeters (pain never before experienced).

Separate function (phthalein intravenously), right, 4 minutes; left 3 ½ minutes.

First 15 minutes output, right, 26 cubic centimeters, 4 per cent; left, 40 cubic centimeters, 19 per cent.

Second 15 minutes output, right 14 cubic centimeters 3 per cent; left, 35 cubic centimeters 9 per cent.

Bladder catheterized and no phthalein found in contents at the end of thirty minute period.

Ureteropyelography. Marked elongation and deformity of right renal pelvis, left normal (Fig. 2).

NOTE —In this case the clinical evidence (pain, hæmaturia, tumor, emaciation and cachexia) makes the diagnosis probably certain but, correlated with the definite urological evidence (right renal bleeding, reproduction of right renal pain, reduction of function, identification of tumor and pelvic deformity), the diagnosis becomes absolutely certain. Patient refused operation, still living.

CASE 3. No. 9272, U. C. H., male, age 43. Onset two months ago with dull steady pain in the left back. Has never noticed blood in the urine. On examination a large mass is felt high in the left flank behind the splenic flexure of the colon. The right side is negative. X-ray shows two stone shadows in the right kidney region and an enlarged kidney.

Cystoscopic examination, May 25, 1915, shows the left kidney to be functionless and only a few drops

of pus obtained from it. From the right (the side with stones) fair function and apparently normal urine obtained.

Autopsy. Carcinoma of the left kidney and left perinephritic abscess; hydronephrosis and nephrolithiasis of the right side.

NOTE — This report shows the extent of renal damage that may take place before the onset of symptoms. The pressure of stones in the opposite non-malignant kidney and their absence on the tumor side, is of interest in view of the reputed causative influence of stones in malignancy.

CASE 4. No. 91, P. C., male, age 60, referred by Dr. H. C. Moffitt, with diagnosis of polycystic kidney. In 1900 had first severe attack of pain in the left hypochondrium which recurred ten years later and had been occasionally felt since then. This pain has never been severe enough to demand opiates; never radiates; never accompanied by urinary disturbances. A mass has been noted in the left side since 1910 which last year presented an irregular surface. A mass has recently become palpable in the opposite right flank. For the past ten years there have been varying periods of urinary frequency. At present, the patient urinates three to four times at night but has no difficulty, burning or dribbling. Two weeks ago had a rather severe attack of left-sided pain followed in two days by blood in the urine, the first attack of hæmaturia.

Examination shows a beginning prostatic hypertrophy, small residual. Blood pressure, 160 to 180.

Total phthalein test in January, 1914, 42 per cent in two hours and ten minutes. On August 27, 1915, 38 per cent in the same time. Plain X-ray, negative, except for enlarged kidney shadows. Bladder urine has been negative until the last two weeks when it has shown red blood-cells, microscopically.

Functional study. Urine from the right side is pale as compared to rather highly colored urine from the left. Injection of 6 cubic centimeters on the right side causes pain deep in the right back, never before experienced. Injection of over 20 cubic centimeters on the left causes no sensation in the back. Specimens of each side, negative, microscopically, except for occasional leukocyte found on the left.

Total phthalein test, right, 4 minutes; left 7 minutes. First 15 minutes output; right 52 cubic centimeters, 22 ½ per cent; left, 66 cubic centimeters, 5 per cent. Second 15 minutes output, right, 56 cubic centimeters, 10 per cent; left, 54 cubic centimeters, 5 per cent.

Patient taken to the X-ray room and double ureteropyelogram taken (Fig. 3).

NOTE — The clinical evidence in this case indicating polycystic kidney receives definite confirmation in the urological study. The "spider-leg" pyelogram is typical.

GROUP II. HÆMATURIA, PAIN, OR BOTH

CASE 5. No. 238, P. C., male, age 42. First noticed sensation of heaviness in the bladder in 1912, which caused a frequent desire to urinate. Careful examination of the urine at this time was

Fig. 1. End of cystoscope in bladder manikin showing rubber sheath applied to ureteral orifice.

negative. These symptoms lasted for three or four months and completely disappeared. In June, 1915, there was a recurrence of heaviness in the bladder and possible appearance of blood in the urine. On October 27, 1915, patient definitely noticed the passage of three or four blood-clots at the beginning of urination and, two hours later, suffered for two hours severe pain in the lower abdomen.

Physical examination, negative. Neither kidney palpable. There has been some loss in weight and the patient appears somewhat emaciated.

X-ray examination, negative.

Total phthalein test, 64 per cent in two hours and ten minutes.

Urine shows, microscopically, a few red blood-cells, no pus-cells, no organisms.

Examination for tubercle bacilli, negative, and a guinea pig inoculation negative, six weeks later.

Cystoscopic examination (1916). Bladder negative; ureteral orifices negative. No renal bleeding. Both ureters catheterized. Cultures of specimens negative.

Functional test unsatisfactory because of marked inhibition of function on the right side, appeared on the left in less than four minutes. Ureteropyelogram not taken. Examination not repeated because of objections of patient who very soon afterward left San Francisco. The case has been followed, however, and in three to four months developed a large palpable tumor in the right side; became cachectic and unable to stand an operation.

Autopsy, May 4, 1916: Right kidney and suprarenal fused forming a tumor mass the size of a year-old child's head, consisting of tumor tissue surrounding the lower pole but apparently normal kidney cortex. Tumor white with brownish, greenish, and yellowish spots and streaks with central necrosis. Metastatic tumors in the left lobe of the liver and the lungs, one on the left heart and one on the left suprarenal and a few in the left kidney.

NOTE — The unusual onset symptom, bladder discomfort and urinary frequency, gave no indication of the renal tumor. Urine was negative except for the one attack of

Fig. 2.

Fig. 2. Case 2. Renal tumor. Marked distortion of pelvis and calyces. (Compare with opposite pyelogram of the healthy kidney—tricalyx.) The pelvis is elongated and constricted by the pushing in of the tumor mass at *x*. The lower major calyx *a* is almost obliterated, the middle one *b* following the pelvic retraction is displaced upward at base, the upper *c* is constricted and nodular. Minor calyces, plainly seen on opposite side, are indistinguishable.

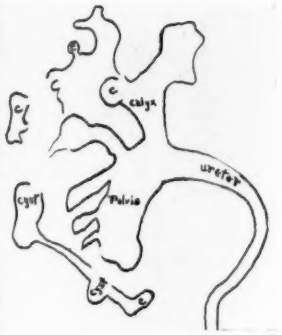


Fig. 3.

Fig. 3. Case 4. Polycystic kidney, bizarre distortion of pelvis and calyces, the original type of which is now unrecognizable. The ureter is displaced in a wide sweeping curve. The pelvis is angularly misshapen. The calyces have long narrow necks ("spider leg") connecting with many irregular sac-like dilatations *c* distally. The rod-shaped offshoots (6 or 7) with their bulbous ends indicate cystic degeneration.

hæmaturia. Unfortunately, a pyelogram was not made at the time of the cystoscopic examination as this might have made the diagnosis. The hæmaturia of short duration and infrequent occurrence is significant in this case (Compare Cases 6, 10, and 11). And the importance of obtaining as complete information as possible at one cystoscopic examination is emphasized by the incompleteness of the one and the patient's refusal to allow a second.

Case 6. No. 122, P. C., male, age 60. Essential hæmaturia (referred by Dr. H. C. Moffitt). Perfectly well up to two months ago when after heavy work (gold miner) noticed blood in the urine. Hæmaturia has persisted except for occasional periods of twenty-four hours when the urine would be almost clear. No loss of weight, no pain. Blood-pressure 145. Right kidney barely palpable; not tender or irregular. Cystoscopic examination and functional study, negative. Guinea pig inoculation negative. Urine negative except for red blood-cells.

Hæmaturia stopped after lavage of the kidney pelvis with adrenalin solution (1:2000). Patient

Fig. 4.

Fig. 4. Case 6. Normal pelves with minor calyces clearly outlined and connecting directly to the pelvis without any definite division into major calyces. (Kidney probably lobulated.)

Fig. 5.

Fig. 5. Case 7. Nephroptosis with infection. Pelvis dilated. Minor calyces indistinguishable. Major calyces blunted and irregular as result of infection.

Fig. 6.

Fig. 6. Case 8. Renal tuberculosis. Marked dilatation of the ureter and pelvis. Extensive cystic degeneration of renal parenchyma which by its symmetry (compare polycystic kidney Fig. 3) and the character of the urine (which on examination was found to contain pus and tubercle bacilli) is indicated as inflammatory in origin. (See Fig. 7.)

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 7. Case 9. Grape-cluster pyelogram (similar to Fig. 6) typical of caseocavernous renal tuberculosis. Note marked ureteral dilatation in its iliac portion.

Fig. 8. Case 11. Pyelonephritis with multiple abscesses. Ureter is dilated and nodular. Calyces are retracted and irregularly blunted. No evidence in pyelogram of abscess formation.

Fig. 9. Case 12. Renal hypertrophy. No infection. Bifid pelvis with unusual ramification and branching of both major calyces. Minor calyces indistinct. (Compare Fig. 8.) Nephrolithiasis with complete destruction of opposite kidney. (See Figs. 10 and 11.)

Fig. 10. Normal bifid pelvis. Minor calyces well outlined. (Compare Figs. 9 and 11.)

Fig. 11. Normal bifid pelvis with pronounced branching. (Compare Figs. 9 and 10.)

returned home and after heavy lifting, hæmaturia recurred. Patient returned and double pyelogram made, with negative findings (see Fig. 4). Right pelvis again irrigated with adrenalin and finally with 1 per cent silver nitrate. Following the silver nitrate injection bleeding ceased and the patient returned home on April 28. In a letter, July 17, he states that there has been no return of bleeding.

NOTE — The continuous profuse bleeding in this case contrasts markedly with the slight hæmorrhage of Cases 2 and 5. The normal pyelogram gives a welcome assurance of the absence of neoplasm.

CASE 7. No. 217, P. C., male, age 40. Stricture of the lower end of the ureter. Slight hydro-ureter and hydronephrosis. Perfectly well until Thursday night after a fifty-mile automobile ride when he was

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 12. Case 13. Normal pelvis. The ureter sweeps outward over a large inoperable retroperitoneal sarcoma.

Fig. 13. Case 14. Perirenal abscess, suprarenal and retrorenal. Marked compression of pelvis and distortion of calyces from perirenal pressure simulating tumor deformity.

Fig. 14. Peculiar pyelogram simulating renal tumor probably due to pelvic spasm at the time of the injection of the thorium nitrate but obtained at a second confirmatory examination. Clinical finding of tumor in the region of the right kidney which further confuses the diagnosis. Cystoscopic and functional studies negative.

Fig. 15. Hypernephroma of upper pole of right kidney. Note the many large capsular blood-vessels.

awakened at 4 a.m. with severe left-sided renal colic, demanding one-half grain of morphine. The pain was deep in the left hypochondrium but did not radiate. Has never before had a similar pain and the pain has not recurred. Physical examination negative. Urine negative except for occasional red blood-cell. Guinea-pig inoculation negative. Plain X-ray negative and wax-tipped catheters negative.

Cystoscopic examination and functional study reveals stricture of the ureter about 2½ centimeters from the bladder which was with difficulty dilated to admit No. 5 and No. 6 catheters.

Pyelogram shows definite dilatation of the lower end of the ureter and a beginning dilatation of the pelvis and lower major calyx of the kidney. Pain definitely reproduced. Tumor definitely excluded. Guinea-pig inoculation negative. Stricture has been dilated with complete relief. Gives a history of repeated severe attacks of tonsillitis which is the probable origin of the stricture (Hunner, 20).

Cases 8 and 9. No. 10213, U. C. H., No. 148, P. C., renal tuberculosis, are of interest in this connection with reference to their typical pyelograms (Figs. 6 and 7). Renal tuberculosis was diagnosed in Case 8, in whom it was impossible, even upon repeated attempts, to catheterize either ureter, by the cystoureteropyelogram (Fig. 6), which was made by overdistending the bladder with the patient in the Trendelenberg position, the diseased ureter on the left side allowing the injected solution (thorium nitrate) to gravitate to the kidney. Diagnosis in each case confirmed by nephrectomy.

GROUP III. TUMOR

Case 10. No. 182, P. C., widow, age 59. Nephroptosis, pyonephrosis (referred by Dr. Alvarez). Has noticed for more than forty years a mass in the lower right abdomen which caused no trouble until two weeks ago when she had pain in the right side and back, followed two days later by hæmaturia. Complete cystoscopic examination makes the above diagnosis.

Pyelogram disclosed the retracted dilated character of the pelvic deformity which condition indicates infection and back pressure rather than tumor encroachment.

Case 11. No. 10722, U. C. H., male, age 55. Unilateral pyelonephritis with multiple abscesses. Has had urinary symptoms for several months and pus and blood in the urine, and, clinically, suspicion of renal tumor is given because of loss of weight, of growing emaciation and of the presence of a nodular, very hard palpable mass in the region of the kidney. Cystoscopy and functional study reveals pyelonephritis. Pyelogram (Fig. 8) gives no suspicion of tumor but indicates infection. Nephrectomy, the removed kidney showed numerous small abscesses which, with the perirenal infiltration caused the hard nodulation noted in the clinical examination.

Case 12. No. 10203, U. C. H. Nephrolithiasis, right; nephrectomy, right; renal hypertrophy, left. Is of interest because of the peculiar pyelogram (Fig. 9, compare with Fig. 3).

Case 13. No. 166. P. C. Referred by Dr. J. C. Blair, San Jose, for urological examination. Retroperitoneal sarcoma. Young girl, age 19, with a tentative diagnosis of hypernephroma, enlarged spleen or retroperitoneal sarcoma, presents a large palpable mass in the kidney region. Functional study gave negative findings and pyelogram (Fig. 12) shows the kidney in normal position and with pelvis of normal outline. The ureter is seen to be pushed to one side by the extrarenal tumor. Operation, (Dr. Terry) inoperable retroperitoneal sarcoma.

GROUP IV. SUSPICIOUS UROLOGICAL FINDINGS

Case 14. No. 10800, U. C. H. Perirenal abscess, drainage. The case is of interest because of extrarenal compression of the upper pole of the kidney by the perirenal abscess, as shown in Fig. 13. At operation, the abscess was found above and behind the kidney. Complete recovery.

Case 15. No. 9697, U. C. H., female, age 33, single. Probable splenic anæmia. Admitted August 9, 1915. About one month ago first began to notice peculiar whiteness of the skin. Since this time has had definite gastro-intestinal symptoms, abdominal distentions, sometimes nausea, followed by vomiting. There has been some swelling of the legs. Never any hæmaturia. No frequency, no pain in either lumbar region.

Physical examination negative, except for large mass in the right flank which presents an edge with a round, hard tumor independently movable beneath it. Spleen is palpable. Blood examination on admission showed 20 per cent hæmoglobin, 2,760,000 red blood-cells, 7,600 white blood-cells. Differential count showed 84 per cent neutrophiles, 0.4 per cent eosinophiles, 0.4 per cent basophiles, lymphocytes, 6.4 per cent large mononuclears and no myelocytes.

Urological examination. Urine negative. Total phthalein 45 per cent in two hours. Ureteral catheterization showed urine from both sides clear and

function on both normal. Pelvic capacity of the right side was only 4½ cubic centimeters and 6 cubic centimeters of collargol injected by gravity through the ureteral catheter produces characteristic pain but which the patient is positive she has never before experienced. Pyelogram (Fig. 14) shows three islands of collargol with a streak in the ureter below, which picture might be interpreted as typical of tumor deformity. To avoid error a second pyelogram was made and proved to be identical with first. Exploratory operation by Dr. Terry. The most probable clinical diagnosis was hypernephroma. The evidence for this was twofold. The mass was evidently below the edge of the liver and apparently independent of it, and the peculiar pyelogram which was obtained upon two separate examinations corresponded in position to this mass and in its deformity was typical of tumor. The complete absence of urinary symptoms, the absence of renal pain and the continued absence of blood in the urine and the normal renal function, all suggested that the tumor was not connected with the kidney. At the exploratory operation, the anterior portion of the liver was seen to be bent forward upon the main body of the liver, which lay in the flank. This malposition allowed the different parts of the liver to move apparently independent of each other. The ptosis of the liver held up the right kidney so that it could not be palpated clinically but there was apparently no evidence of pressure on the kidney, which would be the simplest explanation of the peculiar pyelogram. Probably pelvic spasms which prevented complete distention of the pelvis and ureter, occurred at both examinations to give the distortion.

Case 16.[1] U.C., No. 11768, J. G., age 38, married. Admitted, July 17, 1916. Complaint: difficulty in urination due to blood-clots in the bladder.

As long as 20 or 22 years ago, patient noticed that the urine would be colored slightly red for two or three days at a time. This condition would recur every two or three months. There was no pain or other symptom associated with the appearance of blood. Eight years ago patient was seized with severe pain in the right lumbar region which radiated into the right testis and was accompanied with marked hæmaturia. For the next two or three years, at intervals of about six months, and lasting usually for a few days only, the patient would pass numerous blood-clots, often accompanied with severe pain in the right lumbar region. During the past five years these attacks have occurred every three or four months. The patient has been under continuous medical supervision for about five years and two years ago he had a cystoscopic examination which, so far as known to the patient, gave negative findings. Upon admission it was not possible to get a total phthalein test because of the large amount of blood in the urine. Plain X-ray examination at this time showed irregular shadows in the region

[1] This case has been seen and operated on since the reading of this paper in April, 1916, but is now added for its considerable clinical interest.

Fig. 16. Sagittal section of tumor (Fig. 15) shows the normal appearing lower pole of the kidney with the pelvis completely shut off by tumor encroachment. No bone or calcifications (teratoma) to explain shadows found in clinical X-ray examination. Probably shadows cast by dense masses of tumor degeneration, as shown in the center of photograph.

of the right kidney which were suspicious of calcifications due to an old tubercular process.

Cystoscopic examination, July 19. A blood stained stream could be seen to spurt from the right ureter. Bladder otherwise negative. Both ureters easily catheterized. The right side failed to function, even after repeated stimulation with sterile water injection. It was not possible to inject more than three or four cubic centimeters upon the right side before the patient would complain of severe pain in the right lumbar region, which simulated in position and character the pain of which he has suffered so long. The urine from the left side was negative except for a few red blood-cells, microscopically and bacteriologically. Phthalein appeared on the left side in five minutes; output of 10 per cent in the first fifteen minutes. Double pyelography showed a perfectly normal appearing left pelvis and ureter, the major and minor calyces being well defined and negative, whereas, on the right side, even though the solution had been allowed to run by gravity until the patient complained rather bitterly of pain, no thorium could be seen in the kidney region, and the ureter was outlined for only a short distance above the bladder.

On July 25 cystoscopic examination was repeated and the above findings, of right renal bleeding, of reproduction of renal pain and absence of right renal function were confirmed. A second attempt at this time to outline by pyelography the right kidney was again unsuccessful, no thorium being present in the kidney region, even though the patient complained of considerable pain at the height of injection. Total phthalein on July 26, first hour, 42 per cent, second hour, 14 per cent, total of 56 per

cent. X-rays of the thorax and long bones were negative for evidence of metastatic noduies. Operation, July 27, gas and oxygen anæsthesa. There was exposed by the lumbar route a tumor which lay completely above the costal margin, displacing the right lobe of the liver sufficiently to cause a momentary suspicion that the liver itself was being resected. Reassurance was immediate with extraperitoneal confirmation. The capsule of this tumor contained very large venous channels (Fig. 15), each of which required ligation. The lower pole appeared to consist of normal kidney tissue but the upper four-fifths was irregularly nodular (Figs. 15 and 16). There was apparently no tumor invasion of the pelvis, ureter or of the renal vein or the vena cava. Two enlarged lymph-glands at the pedicle were removed. Subsequent microscopical examination of these glands showed no metastasis. The tumor, microscopically, showed typical large vesicular cells, commonly characteristic of hypernephroma.

Convalescence was uneventful. Total phthalein, August 11, first hour, 38 per cent, second hour 16 per cent. Patient discharged August 13.

NOTE — This case presented symptoms for an unusually long period, over twenty years, before a diagnosis was made. At the time of the cystoscopic study complete clinical evidence obtained: hæmaturia for twenty years, pain for eight years, tumor indefinitely noted upon examination; but the finding at the urological examination of renal bleeding, reproduction of renal pain, absence of renal function and a closed pelvis definitely indicated the necessity of nephrectomy which was shown to be, in all probability, subsequent to the presence of a renal tumor.

REFERENCES

1. KELLY, A. O. J. Beitr. z. path. Anat. u. z. allg. Path., Jena, 1898, xxiii, 280.
2. KROENLEIN. Cor.-Bl. f. schweiz. Aertze, 1905, xxxv, 409.
3. BARNEY. Boston M. & S. J., 1913, clxvii, 300.
4. SWAN. Lancet, Lond., 1913, Feb. 8, 376.
5. GARCEAU. Renal Tumors, etc. 1909.
6. GREGOIRE, RAYMOND. Contribution au traitement du cancer du rein, chez. 'adulte. Paris, 1905.
7. KUESTER. Deutsch. Chir., 1902, No. 52.
8. ISRAEL, JAMES. 1894. Cited by Willan.
9. ALBRECHT. Arch. f. klin. Chir., 1905, lxxviii, 1073.
10. HENDON. Kentucky M. J., 1908, vii, 747.
11. DENALLARA. N. Y. M. J., 1915, cii, 1093.
12. WILLAN. Brit. M. J., 1915, ii, 269.
13. SQUIER. Boston M. & S. J., 1909, clxi, 547.
14. WEBER. Proc. Roc. Soc. Med., 1915, viii, 6.
15. PLESCHNER. 1913.
16. NOGUIRA. Am. J. Urol., 1915, xi, 216.
17. CORYELL. Bull. Johns Hopkins Hosp., 1915, xxvi, 93.
18. HINMAN. J. Am. M. Ass., 1915, lxiv, 2129.
19. BRAASCH. J. Am. M. Ass., 1913, lx, 274.
20. IMBERT. Gaz. d. hôp., 1903, lxxvi, 631.

TUBERCULOSIS OF THE THYROID

BY ROSCOE E. MOSIMAN, M.D., CLEVELAND, OHIO
From the Surgical Clinic of Dr. George W. Crile

HISTORICAL

IN 1862, Lebert described one of the first cases of tuberculosis of the thyroid gland. A few years later, Cornil and Ranvier reported a case of general miliary tuberculosis with a tuberculous process in the thyroid gland. Chiari, in 1878, found seven cases of tuberculosis of the thyroid gland among one hundred autopsies of patients that had died of some tuberculous infection, and in the same year Dumolard reported a case of a fistula of the neck following a subacute tuberculous process of the thyroid. Virchow saw two cases of miliary tuberculosis and one case of caseous tuberculosis of the thyroid gland. Among the first authors to express the opinion that in general miliary tuberculosis there was always an involvement of the thyroid by the same disease were Cohnheim and E. Fraenkel. Later, Cohnheim described 8 such cases, and E. Fraenkel reported tuberculous involvement of the thyroid gland in all except 6 cases out of 580 autopsies of subjects who had died of general miliary tuberculosis. In 1890, Perry and Voelcker reported 4 cases of general miliary tuberculosis in children, each of which showed, microscopically, tuberculosis of the thyroid gland. In the same year, James Berry exhibited before the London Pathological Society a specimen from a case dying from miliary tuberculosis, and it is interesting to note that on this occasion he stated that he was unable to find a specimen of tuberculous infection of the thyroid in any of the twelve large museums of London, or those of Oxford, Birmingham, Newcastle, Edinburgh, Glasgow, Geneva, Berne, or Zurich. This fact, in addition to the limited number of cases of tuberculosis of the thyroid reported, substantiates the

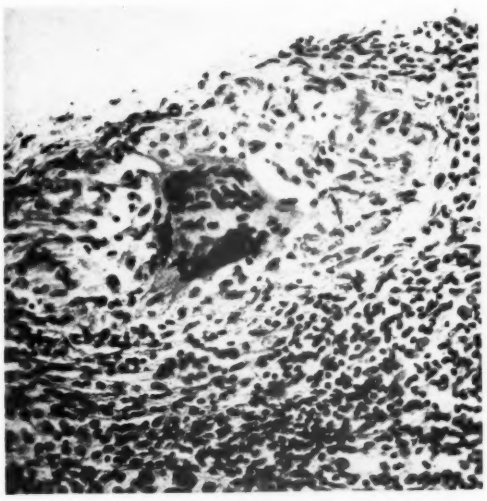


Fig. 1. Case 5. Tuberculosis of the thyroid. There is a complete lack of normal thyroid tissue. The tubercle is isolated and surrounded by a cellular stroma.

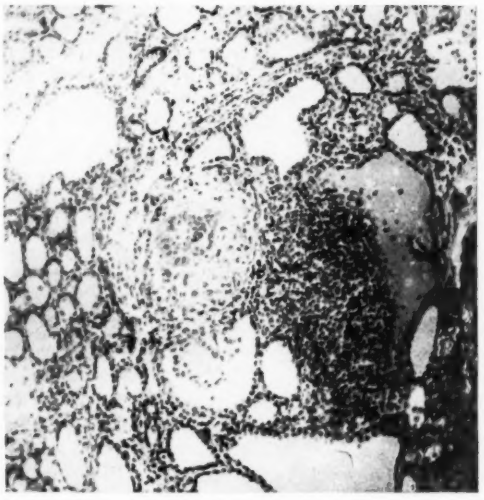


Fig. 2. Case 7. Tuberculosis of the thyroid. The stroma contains an isolated tubercle and an area of round cells.

opinion that most of the earlier authors failed to recognize tuberculosis of the thyroid gland.

So-called primary tuberculosis of the thyroid gland was not described before the year 1890. Bruns was the first to recognize clinically a case of tuberculosis of the thyroid gland which he supposed was primary in the gland. On more critical examination of this case, it was noted that the patient also had enlarged cervical glands and an involvment of the left apex. However, no tubercle bacilli were found in the specimen. Fraenkel reported a case of tuberculosis of the thyroid which involved the trachea and œsophagus, and resulted in a purulent mediastinitis. Schwartz described the case of a man, age 30, with a swelling of the right lobe of the thyroid and with paralysis of the right recurrent laryngeal nerve. This case suggested malignancy. No tubercle bacilli were found, but the microscopic section showed typical tuberculous tissue, and a guinea pig injected with pus from the thyroid gland died of tuberculosis. No other focus of tuberculosis could be made out in this case. In 1902, Clermont reported a case, age 2, which suddenly, without fever, developed enlargement of the neck that rapidly showed fluctuation. The incision demonstrated granulation tissue but no pus. The fistula became infected requiring a second operation, at which time no other evidence of thyroid tuberculosis could be demonstrated. Rolleston reported a case of a man, age 23, with caseous abscesses in the thyroid, one of which ruptured into the œsophagus. The patient died of paraplegia due to caries of the spine. Some years later (1905), Lediard reported the case of supposed primary tuberculosis of the thyroid gland in a man, age 21, who had lived in a goiter district. The enlargement of the thyroid and the elasticity of the tumor pointed to a diagnosis of fluid in a cyst. Cultures of the fluid from the cyst remained negative; microscopic sections of the wall of the cyst showed tuberculous granulation tissue. The author writes, "In the case related, there was no discoverable source of tubercular infection, either prior or subsequent to operation . . . . the patient has remained well and strong in all respects."

Virchow and Demme noted the direct extension of the tuberculous process from the surrounding organs into the thyroid gland. Grasset and Estor saw at autopsy direct extension of the tuberculous process into the

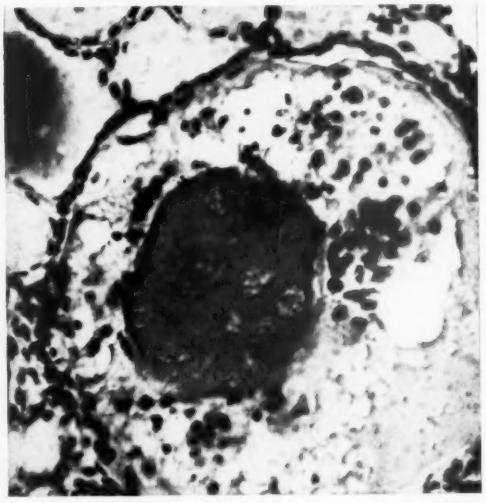


Fig. 3. Case 8. Tuberculosis of thyroid. Intrafollicular (?) tubercle, made up of giant-cells and epithelioid cells.

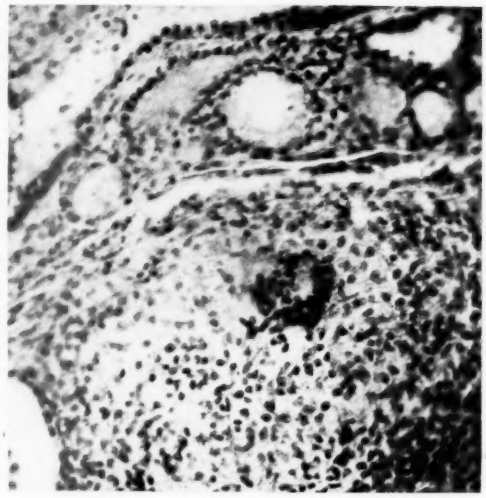


Fig. 4. Case 7. Tuberculosis of thyroid. The well defined tubercle is surrounded by fairly normal thyroid tissue.

thyroid from the cervical lymph-glands. Bérard cites a case in which the tuberculous abscess of the thyroid was consecutive to a laryngeal tuberculosis. This abscess opened and discharged into the œsophagus. In a pregnant patient, Roger and Garnier found a thyroid tuberculosis and a tuberculous involvement of the pharynx. Lenormant noted in a case of tuberculous isthmus of the thyroid an associated tuberculosis of the trochanter. And in addition to the reports of direct extension of tuberculosis involving the thyroid gland, there are numerous cases cited of a thyroid tuberculosis with a general miliary tuberculosis or a lung involvement.

Many of the early textbooks on pathology make no reference to the subject of tuberculosis of the thyroid or give it a very limited space. The texts of later dates discuss the subject more fully. Rokitanski never saw tuberculosis of the thyroid. Virchow expressed the idea that "no organ of the body is so little disposed to tuberculosis as is the thyroid." He also remarks, "It is of the utmost rarety, and usually the result of tuberculosis of neighboring structures, as is the case with muscles." Rindfleisch (1896), Langerhans (1902), and Schmaus (1907) do not mention tuberculosis of the thyroid gland. Birch-Hirschfeld states that the thyroid may become secondarily involved in a miliary process. Ziegler (1902) says that it is not common, but that one may have a disseminated hæmotogenous or a large nodular form. Ribbert (1902) and Kaufmann express the idea that tuberculosis of the thyroid gland is not uncommon in a general miliary tuberculosis. Gierke (1909) says, "In miliary tuberculosis one finds usually involvement of the thyroid; solitary or multiple caseous nodules may be also noted." Adami and Nickolls state that tuberculosis of the normal or of the enlarged thyroid is invariably secondary and due to a hæmotogenous infection which is more common than has been supposed. DaCosta expresses the opinion that tuberculosis of the thyroid is usually a part of a general miliary tuberculosis. He also states, "It is seldom that a local caseating focus occurs, but such cases have been reported."

EXPERIMENTAL

Since investigators have so infrequently noted tuberculosis of the thyroid, many opinions were expressed as to the supposed im-

munity which the thyroid, or even a goiterous patient, possessed against this disease. A goiter was even thought to protect the patient against tuberculosis. As a result of these ideas, experimental work on thyroid tuberculosis was attempted by several investigators. Roger and Garnier, who were among the first of these investigators, injected an emulsion of tubercle bacilli directly into the carotid arteries of rabbits and guinea pigs, and came to the conclusion that the thyroid gland could be infected with tuberculosis. In 1900, Torri injected an emulsion of tubercle bacilli directly into the thyroid artery of dogs, which resulted in a marked infection of the gland in the injected lobe. On the other side, there was a marked proliferation of the epithelium, but only once did he find tubercles in this lobe. He could not demonstrate tubercle bacilli in the colloid material of glands removed ten days after injection, and, because of the fact that micro-organisms do not increase on adding thyroid extract to the culture media, he was led to think that colloid destroyed organisms. Specimens examined from one to three days after the injection showed the bacilli in the colloid material to be granular and to stain much less heavy than the bacilli in the capillary spaces. After three days, many bacilli could be demonstrated in the capillaries and epithelial cells, while only a few granulated forms could be made out in the colloid material. Pneumococci, typhoid bacilli, and anthrax bacilli also were injected, granular forms of which could at times be found in the colloid material after three days; later than three days, they could not be stained at all. From these experiments he came to the conclusion that the colloid material had an antibacterial action for the tubercle bacilli. Tomellini used rabbits and injected tubercle bacilli emulsion into the thyroid artery. He came to the conclusion that the progress of tuberculosis in the thyroid was like that of other organs, and that the elements of the tuberculous process in the thyroid gland of the rabbit were furnished by the blood stream. Shimodaira, experimenting with rabbits and using a constant emulsion of tubercle bacilli which he injected intravenously in decreasing dilutions, found that dilutions that gave a tuberculous infection of the thyroid, spleen, kidneys, and testicles, when properly reduced, would still give tuberculous infection in the spleen, kidneys, and testicles, though leaving out the thyroid. He came to the following conclusions:

1. The thyroid can become infected with experimental tuberculosis by the direct injection of small masses of tubercle bacilli, just as other organs — the spleen, kidneys, and testicles — can become infected.

2. The susceptibility of the thyroid to tuberculous infection is less than in the other named organs.

3. The decreased susceptibility of the thyroid against tuberculous infection is probably united with the special functional activity of the organ.

In discussing the experimental results, Arnd expresses the idea that the method of Shimodaira was more nearly an index of the true relation of the thyroid to tuberculous infection than the work of Tomellini and Torri, which he characterizes as being "too energetic." He is of the opinion that this evidence, associated with the relative lack of tuberculosis of the human thyroid as compared with other parts of the body, substantiates a relative immunity of the thyroid against tuberculosis. Arnd thinks that in miliary tuberculosis the whole body is so flooded with bacilli that the thyroid, as the other organs, is swamped; hence it is neither evidence for or against the relative immunity of the thyroid gland.

In connection with this review of the subject of tuberculosis of the thyroid gland, the writer has to offer for consideration the following material from the Crile Clinic:

CASE 1. Clinical diagnosis: exophthalmic goiter. White male, age 23, complained of goiter. The family history was negative. The patient had had the usual diseases of childhood, including scarlet fever. Seven years ago the patient had had an attack of appendicitis, being bedridden five weeks. One year previous to entry into hospital, the patient had been ill six weeks with "inflammatory rheumatism." There was no history of chronic cough, expectoration, bronchitis, pleurisy, night sweats, dyspnœa, hæmoptysis, or palpitation. The patient was subject to fainting spells, and had lost 20 pounds during the past four months. About eleven months ago, the patient began to have a dull aching pain in the "small of his back," and at the same time, he noted dyspnœa, palpitation, nervous-

ness, and irritability. A few months later, he noted an increase in the size of his neck. About eight months ago he had had another attack of "rheumatism," keeping him in bed for 5 weeks, after which his symptoms had increased. A course of rest and medical treatment was pursued for six weeks, without improvement.

Physical examination. Patient was somewhat nervous. Eye signs, ears, nose, mouth, pharynx, heart, lungs, abdomen, and extremities were negative. The epitrochlear and axillary glands were palpable. The thyroid gland was palpable, especially the right lobe. The gland was not very hard; there were no cystic areas, and no pulsations.

Operation. Right lobectomy and ligation of the left superior thyroid artery. After operation, patient developed a marked tonsillitis. Eleven days after operation, the patient was discharged with marked improvement of the symptoms which were prominent on admission.

Pathological diagnosis: moderate hyperplasia, tuberculosis, and lymphoid tissue.

Gross pathology. Pathological No. 1,040. The specimen consists of the right and the median lobes of the thyroid. Weight 27 grams. The capsule is thickened. On section, the surface shows a uniform grayish, translucent tissue with an increase of stroma and a moderate diminution of colloid. The general appearance is that of a glandular hyperplasia. There are no tumors.

Microscopic examination. The section shows a definite increase of interlobular stroma and a marked increase of small capillaries in the interlobular tissue. There are numerous large patches of lymphoid tissue with definite germinal center formation scattered throughout the stroma. Directly under the capsule, the thyroid tissue is almost completely replaced by round-cell infiltration, much of which shows definite germinal center formations and occasionally imbedded islands of colloid. As one approaches the more central part of the germinal center, one notices that the cells stain less deeply and that the nuclei are much larger that the nuclei at the edge of the germinal center. These nuclei of the germinal center are more or less round or oval in outline and stain diffusely with hæmatoxylin. The chromatin is evenly distributed throughout the nucleus. There are, in the germinal centers, some very large cells with a pale eosin-staining cytoplasm and a pale hæmatoxylin-staining, diffusely scattered chromatin, and an eosin-staining nucleolus. The smaller nuclei at the edge of the germinal center stain more deeply. No definite mitotic figures are seen in the germinal centers.

Most of the follicles are very irregular in shape and size, and contain varying amounts of eosin-staining material. In some areas there are follicles that are filled with deep eosin-staining material and are lined by cuboidal epithelium. Many of the follicles show infoldings of the lining epithelium which is of a high columnar type. There are fields made up of thyroid-cells, many of which are without definite follicular arrangement and show little or no eosin-staining material. There are also follicles containing giant-cells with three to seven deep-staining nuclei but without tubercle formation.

In various portions of the section, there is a complete lack of thyroid tissue pattern, the tissue showing numerous conglomerate tubercles. In other portions, the thyroid tissue is entirely obliterated, having been replaced by fibrous tissue in which there are numerous small round cells. In this mass of fibrous tissue, there are multinucleated giant-cells of the Langhans type, containing a necrotic area. Scattered quite regularly about the giant-cells are epithelioid cells with pale-staining, irregularly shaped nuclei. The tuberculous process is definitely isolated.

CASE 2. Clinical diagnosis: goiter, exophthalmic, mild. White female, age 29, married, mother of two children, complained of nervousness and palpitation of the heart. There had been several goiters in the father's family. The patient's general health had always been good. Three years previous, there was a pleurisy of two weeks' duration. The weight seven months previous was 114 pounds; weight at the time of examination was 148 pounds. The symptoms of nervousness, palpitation, and dyspnœa began about one year prior to entry into hospital, coming on after "drinking beer or soft drinks," and being intermittent and increasing somewhat in severity, especially at the menstrual period, and causing the patient to remain in bed two or three days at a time. The patient had become very faint at times; had had muscular weakness which had increased until the patient was bedridden. The neck had begun to enlarge seven years previous.

Physical examination. There was a slight exophthalmos. The neck measured 35 centimeters; the right lobe of the thyroid gland was larger than the left lobe. There were no bruits or thrills, or palpable cystic areas. The heart was enlarged to the left; a systolic murmur was heard over the whole heart. At the level of the seventh and eighth ribs of the right back, there was heard a friction rub. No enlargement of the lymphatic glands or of the thymus gland was noted. The abdomen and the extremities were negative.

Operation. Lobectomy was performed without technical difficulty. The patient was much improved in general health when she left the hospital twenty days after operation. During the patient's stay in the hospital, the blood pressure was 120 to 150 millimeters mercury, and the pulse was 90 to 140 beats per minute. There was an afternoon rise in temperature, before and after operation, from 99 to 101°.

Pathological diagnosis: colloid goiter with calcified adenoma and tuberculosis.

Gross pathology. Pathology No. 10,861. Specimen consists of a portion of the right, the median, and a portion of the left lobe of the thyroid gland. Weight 65 grams. The capsule of the gland is

slightly thickened, containing enlarged blood-vessels. The gland is soft, uniform, and lobulated. The cut surface is a pale, reddish gray color, semi-translucent, and contains a small amount of colloid. There is a moderate increase of stroma. The general appearance is suggestive of a moderate hyperplasia. At the lower pole of the right lobe, there is a calcified area, about 1 centimeter in diameter, which contains no recognizable adenomatous tissue within its capsule.

Microscopic examination. The microscopic section shows a lobulated structure, an increase of stroma, and a more or less diffuse round-cell infiltration without germinal center formation. The round cells are more frequently noted in the fibrous trabeculæ, and they are not so numerous in the portion of the section where the follicles are more uniform in shape and size, and where there is less fibrous tissue.

The follicles are rather small, quite regular in shape and size, and well filled with deep eosin-staining material, and are lined by flat epithelium. There are no infoldings of epithelium into the follicles or other evidences of active hyperplasia.

In one portion of the section, the follicles are markedly compressed, and there is a great increase of fibrous tissue which shows a marked round-cell infiltration. There are many small, lighter-stained areas which are made up of epithelioid cells and multinucleated giant-cells with areas of necrosis, and which have accumulations of round cells at the periphery. These typical tubercles are to be found in many fields. Another portion of the section shows a granular, purple-staining, calcium deposit which has an area of homogenous, pink-staining bone-tissue (containing bone-cells) and which is surrounded more or less completely by a hyaline and fibrous connective-tissue capsule. Inside of this capsule is an area of œdematous fibrous tissue in which small atrophic follicles are occasionally noted. At the edge of the calcified nodule, there are several typical tubercles. Other sections from the gland show no gross or microscopic tuberculosis.

The section with the bone formation may represent an attempt to encapsulate the tuberculous process by healing with bone formation, or, the bony deposit may be a part of the tissue changes of an adenoma which has been traumatized — an entirely separate pathological process from the tuberculosis with which it is in close association.

Case 3. Goiter, exophthalmic (?). White female, age 18, single, student, complained of goiter. Family and personal history were unimportant. About two months previous, patient noted an increase in the size of her neck, palpitation, nervousness, and slight tremor of the hands. Patient had been in bed for nine weeks previous to examination; had gained in weight; but had lost strength and felt weak. Patient had had eight weeks continual medical treatment with no improvement.

Physical examination. There was no exophthalmus. The neck measured 34 centimeters. The thyroid was soft and freely movable; there were no masses. The heart was enlarged; the lungs, abdomen, and the extremities were negative. The lymph-glands were not enlarged; thymus enlargement could not be made out.

Operation. Lobectomy. In the operative note, it was stated that "there was an unusual number of lymphatic vessels running from the gland." Patient was discharged thirteen days after operation feeling much stronger. Before operation, pulse ranged from 100 to 145 beats per minute; after operation, pulse came down to 90. Blood-pressure ranged from 105 to 130 millimeters mercury. Post-operative temperature was 98 to 102.6°, but was normal on day of discharge.

Pathological diagnosis: hyperplasia with tuberculosis.

Gross pathology. Pathology No. 11,215. The specimen consists of the right and the median lobe of the thyroid gland. Weight 30 grams. The capsule is thickened; the gland is lobulated, fairly firm, and reddish in color. On section, the surface is uniform, reddish gray, and opaque. There is a slight amount of colloid present; there are no tumors. Numerous opaque pin point areas scattered throughout the gland suggest lymphoid tissue. The appearance of the gland is that of a moderate glandular hyperplasia.

Microscopic examination. The microscopic section shows a lobulated structure, a definite increase of delicate interlobular stroma, a marked increase of thin walled blood-spaces, and a diffuse infiltration of lymphoid tissue without germinal center formation. The follicles are very irregular in shape and size. Some follicles show marked infoldings to the extent of papillomatous-like structures, and are lined by high cylindrical epithelium, but contain little or no colloid material. Other follicles have smooth walls; they are lined with a low cuboidal or a flat epithelium; and they contain fairly dense, pink-staining colloid with an occasional vacuolation and a shrinking away from the follicle wall.

Diffusely scattered throughout all the sections, there are tubercles made up of lymphoid cells and epithelioid cells, with quite a definite wall of demarcation between the two types of cells. Occasionally, multinucleated giant-cells are seen in the tubercles. The pattern of the non-giant-cell-containing tubercle is the same histologically as the giant-cell-containing tubercle.

All sections of the thyroid gland show a diffuse tuberculous involvement with a hyperplasia that is more or less localized in certain very small areas.

Case 4. Clinical diagnosis: sarcoma of the thyroid. White female, age 60, housewife, complained of a growth on the right side of the neck. The family and personal history were negative. Sixteen years before examination, the patient had had goiter which had disappeared after using iodine. Eight weeks ago, the patient had noted on the side of the neck a "bean" shaped nodule which grew quite rapidly to the size of a lemon, but which did

not cause discomfort. The mass was quite hard, movable under the skin but attached to the deeper structures, and not sensitive or nodular. The thyroid gland was easily palpable but not markedly enlarged.

Physical examination. The chest was hyperresonant; there were dry rales heard over both upper backs. The heart was enlarged. The abdomen and extremities were negative.

Operation. Lobectomy. At the time of operation, there was thought to be a malignant tumor of the thyroid. Blood-pressure 120 millimeters mercury. Pulse 72 to 115 beats per minute. Temperature ranged from 97 to 99.5°.

Pathological diagnosis: sarcoma and tuberculosis of thyroid.

Gross pathology. Pathology No. 11,927. The specimen consists of the right lobe of the thyroid gland. Weight 45 grams. At the upper pole and imbedded in the thyroid tissue, there is a large, stony hard, irregular mass which is 4 centimeters in diameter. The surface of the lobe is irregular, nodular, and has some muscle-tissue attached to it. The lower half of the lobe contains several soft and several hard, encapsulated, congenital adenomata. On the posterior surface, there is a hæmorrhagic cyst which is 1.4 millimeters in diameter and which has a thick calcified wall. The original thyroid tissue is markedly atrophic. The section through the hard mass at the upper pole shows a central hyaline and calcified area, 1.4 centimeters in diameter, which is probably a calcified adenoma. A margin of tumor-tissue, 1 to 2 centimeters thick, surrounds this calcified nodule. This tumor-tissue is uniform in appearance and of a translucent grayish color; no cellular débris can be expressed or scraped off from the surface. This tissue has the general appearance of sarcoma.

Microscopic examination. The microscopic section shows a definite increase of stroma with a round-cell and a pus-cell infiltration, and an increased vascularity. There are no germinal center formations. The follicles are irregular in shape and size. Some follicles are compressed; some well filled with deep-staining colloid; others contain little or no, shrunken, or vacuolated colloid; all are lined by low cuboidal or a flat epithelium; none show infoldings.

Most of the section is made up of tumor-tissue, a small part of which is composed of round epithelial-like cells arranged in columns and separated by very thin walled blood-vessel spaces, while the most part is made up of a rather homogenous type of cell with an unusually large irregular nucleus which contains a red- or a blue-staining nucleolus and a diffusely scattered chromatin. The tumor-tissue shows many mitotic figures. Here and there masses of deep-staining colloid material without attached follicular epithelium are caught among the tumor-cells.

Throughout the tumor-tissue, there are more or less circumscribed tubercles having a round-cell infiltration about the periphery, epithelioid cells in their characteristic arrangement, and occasionally giant-cells or areas of granular necrosis. This same type of tubercle can be demonstrated in the non-tumorous thyroid tissue. There are no intrafollicular tubercles noted.

CASE 5. Clinical diagnosis: exophthalmic goiter. White female, age 25, housewife, complained of "bulging eyes." There had been several cases of "scrofula" in the family. Patient had always had difficulty in breathing through her nose, had had tonsillitis every winter, and a cough for years. She perspired freely, and had had night sweats often. One year before entry into hospital, there was extensive loss of hair; four months later, the eyes began to bulge. At the same time, patient had had palpitation and increased nervousness. She became weak and easily exhausted, and her hands and feet perspired freely.

Physical examination. On examination, there is found a marked exophthalmus, a positive von Graefe, a Moebus, and a Stelwag sign. The tonsils were large and nearly met in the midline. The heart was enlarged; the lungs were practically negative. The thyroid was symmetrically enlarged, and there was a slight bruit. No tumors were palpated. There were numerous glands palpated on both sides of the neck and in both axillæ.

Operation. Lobectomy, without technical difficulties. Blood-pressure was 130 to 155 millimeters mercury. Pulse varied between 90 and 130 beats per minute. Temperature was 97 to 102°, with a suggestive afternoon rise during convalescence.

Pathological diagnosis: hyperplasia and tuberculosis.

Gross pathology. Pathology No. 11,975. The specimen consists of the right, the median, and a part of the left lobe of the thyroid gland. Weight 55 grams. The capsule is thickened and contains numerous large blood-vessel spaces. Through the capsule, the gland feels firm. On section, the surface is reddish gray, lobulated, opaque, has very little colloid, and has considerable increase in stroma. There is a marked glandular hyperplasia; no tumors are evident. The tonsils show lymphoid hyperplasia and slight chronic inflammatory reaction.

Microscopic examination. A part of the section shows a marked increase of stroma, increased vascularity, and a slight round-cell infiltration without germinal center formation. The follicles are irregular in shape and size, containing little or no colloid, and showing many infoldings and masses of thyroid cells which are of a tall, columnar type.

Another part of the section shows minute tubercles closely packed together and separated by compressed thyroid follicles. Many of these tubercles have a more or less definite capsule which is composed of spindle-shaped cells with long, slender nuclei. These capsules, containing epithelioid cells and occasionally a giant-cell of the Langhans type, separate the tubercles from the compressed thyroid follicles. The stroma shows a diffuse, round-cell infiltration without germinal center formation. In

this section, the tubercular process is in the stroma; no intrafollicular tubercles are noted.

CASE 6. Clinical diagnosis: exophthalmic goiter. White female, age 24, married, complained of swelling of the neck. The patient had fairly good health as a child. Eleven years ago, patient had had adenoids removed; five years ago, she had had an operation for goiter; three years ago, she had had "rheumatism"; one year ago, she had had pleurisy. Dizzy spells, swelling of the feet, and dyspnœa which compelled patient to sleep with head elevated were noted. There had been a loss of 23 pounds in weight during the past year. Eight years ago, the goiter was first noted; one year later, there was exophthalmus, dyspnœa, palpitation, and increased nervousness. The patient had had "electric treatment" and iodine treatment in the hospital without results. Two weeks after the first operation for goiter, the patient had had typhoid fever for eight weeks, after which time the neck again increased in size and the previous returned. There had been attacks of diarrhœa during the time previous to entry into hospital, also increased appetite and weakness on exertion.

Physical examination. The skin was soft and moist and there was some œdema of the extremities. There was slight exophthalmus, but no other eye signs were noted. In the median line, there was a mass 3 x 4 centimeters; on the left side, there was a mass 7 x 8 centimeters in size. A thrill was felt and a bruit heard over the gland. The heart was enlarged; the lungs were negative.

Operation. Seven days before thyroidectomy, the left superior thyroid artery was ligated. At operation, the thyroid gland was very adherent, and part of it was below the clavicle; consequently, during its removal, there was a brisk hæmorrhage. During the operation, the pulse reached 170 beats per minute. On discharge, the general condition, with the exception of paralysis of the left vocal cord, was improved.

Pathological diagnosis: hyperplasia and tuberculosis.

Gross pathology. Pathology No. 12,578. The specimen consists of part of the left and the median lobes of the thyroid gland. Weight 142 grams. The gland is firm; the capsule is thickened; and the vessels are markedly congested. On section, the surface is uniform reddish brown, opaque, lobulated, and shows here and there a slight amount of colloid. There is a definite increase of fibrous tissue and a moderate increase of blood spaces but no tumors.

Microscopic examination. The section shows a definite lobulation and an increase of interlobular stroma. There is also a definite increase in vascularity, and an occasional accumulation of lymphoid tissue, but no germinal center formation. The follicles are very irregular in size; many are small, others are quite large; all contain a pink-staining colloid, showing separation from the epithelium or showing vacuolation; and all are lined by columnar or a high cuboidal epithelium. The histological picture is that of a definite active hyperplasia of the thyroid gland.

In the stroma, there is found an occasional solitary tubercle, but, more frequently, there are whole groups of tubercles which are scattered about large venous spaces. Among the groups of tubercles the thyroid follicles have disappeared to a great extent, with the exception of a few epithelial cells which form the remains of a follicle. Throughout the tissue, there is a round-cell infiltration with a concentration of round cells at the periphery of the tubercles which are made up of large epithelioid cells and, usually, with a multinucleated giant-cell. At the edge of the tubercular process, there are a few intrafollicular giant-cells. The picture in its entirety shows very little exfoliation of epithelial cells.

CASE 7. Clinical diagnosis: Goiter, exophthalmic. White female, age 38, housewife, complained of goiter. Two brothers had had goiter and an aunt living in the same house had pulmonary(?) tuberculosis. At twenty-two years of age, the patient had kidney trouble. During childhood, there were occasional attacks of tonsillitis; otherwise, the personal history was negative. About nine months before entry into hospital, there was a slight swelling of the right side of the neck which increased gradually in size. The patient had lost 40 pounds during the last 5 months before examination. Nine weeks ago, palpitation, tremor, and increased nervousness were first noted. Patient had become irritable, weak, and had had some loss of hair. The skin was sallow, and the bowels were constipated. There had been no vomiting, diarrhœa, increased appetite, polyuria, menstral disorder, erythema or acne, hoarseness or cough. Eight weeks before examination, patient had had medical treatment which consisted of diet, rest, digitalis, and bromides, and which had reduced the pulse from 160 to 120 beats per minute, but had had no lasting result. Two years previous, while doing heavy lifting, patient had had an injury of her back, after which time there was noted an increased nervousness.

Physical examination. The eyes reacted to light and accommodation; and there were no positive eye signs. Tonsils were small and atrophic. Nearly all of the teeth had been removed. The postcervical lymph-glands were palpable, but the scalp was clean. There was a definite increase of the right thyroid lobe and a slight increase of the left lobe. The thyroid gland was moderately soft, movable, and not tender. A slight bruit was heard over the right lobe, but there was no palpable thrill. There were no abnormal findings in the lungs. The heart was enlarged to the left, and there was a systolic murmur at the apex. Abdomen and extremities were negative.

Operation. Partial thyroidectomy.

Pathological diagnosis: hyperplasia and tuberculosis, and adenoma.

Gross pathology. Pathology No. 12,766. The specimen consists of a part of the right, the median,

and a part of the left lobe of the thyroid gland. Weight 50 grams. The capsule is somewhat thickened, and shows numerous adhesions. On section, the gland is made up of tumorous and non-tumorous tissue. There are two adenomata of the congenital type: one is 2 centimeters in diameter, and the other 1 centimeter in diameter. Each of the adenomata is well encapsulated, rather opaque, and contains areas of an old hæmorrhage. Throughout the gland, there are colloid adenomatous nodules varying from 2 millimeters to 1.5 centimeters in diameter, slightly encapsulated, transparent, and usually non-pigmented. There are a few colloid retention cysts varying from 1 to 2 millimeters in diameter. In the compressed thyroid tissue about the larger congenital adenomata, there are pinpoint opaque dots not unlike fibrous scars or lymphoid accumulations.

Microscopic examination. Grossly, the microscopic section is made up of an encapsulated, non-lobulated adenoma, and lobulated, compressed thyroid tissue. The adenoma is made up of colloid and non-colloid containing follicles and large clear spaces. The compressed thyroid tissue takes a rather diffuse nuclear stain which suggests a marked round-cell infiltration.

The section shows that the compressed thyroid tissue is composed of an increased stroma with a diffuse round-cell infiltration in some places. There are also numerous tubercles in the compressed thyroid tissue, but there are none in the adenomatous tissue. The normal lobulation of the thyroid tissue is lost. The follicles are irregularly deposited; they are usually of a fairly regular outline; they contain deep or pale-staining colloid and desquamated cells, between which there has been a marked vacuolation of the colloid; and they are lined by a flat or a low cuboidal epithelium. Many follicles contain multinucleated giant-cells, the necrotic areas of which are usually indistinguishable from colloid masses of the original follicle. About the intrafollicular giant-cells, there are cells of the epithelioid type. Surrounding the giant-cell containing follicles, there is a definite round-cell infiltration. The stroma also contains tubercles made up of multinucleated giant-cells, epithelioid cells, and round cells. In fact, much of the stroma has been replaced by tuberculous tissue. If the multinucleated giant-cells and associated epithelioid cells are characteristic of a tuberculous process of the intrafollicular type, then this section is made up almost entirely of the intrafollicular type of tuberculosis.

In the adenomatous, as well as in the non-tumorous part of the thyroid tissue, there are accumulations of lymphoid tissue but no definite germinal center formations.

Even after the microscopic demonstration of tubercles, one cannot make out, with any satisfaction, areas in the gross which are tuberculous. Sections taken from some areas show tubercles, while sections takes from others, just as suggestive of tuberculosis, show none.

The specimen shows the difficulty of locating tuberculosis grossly, and suggests that if all gross specimens were completely sectioned a much higher percentage of tuberculosis of the thyroid gland would be observed.

CASE 8. Clinical diagnosis: hypertonus. White female, age 47, music teacher. The patient had had fairly good health until the onset of the illness. At ten years of age, the patient had "sore eyes," which condition was relieved by treatment. No history of cough, expectoration, or dyspnœa were obtained. Present illness began about two or three years before entry into hospital with slight deafness, throbbing headaches, and "specks before the eyes." Six months previously, there had been a hæmorrhage from the uterus. The uterus was removed and a fibroid tumor found.

Physical examination. Hearing was somewhat diminished. Eyes reacted to light and accommodation, but there was a slight clouding of the lenses. There was also evidence of an old keratitis, and typical "Hutchinson's tooth" above. The reflexes were increased, and there was a dorsoflexion of the great toe on stimulating the plantar surface on the left. The heart was enlarged; the lungs were negative; and the abdomen was negative. The blood-pressure was very high: systolic, 180 to 220 millimeters; and diastolic, 130 to 155 millimeters mercury. The urine showed a trace of albumin and hyaline and granular casts.

Operation. Thyroidectomy, partial.

Pathological diagnosis: colloid goiter with tuberculosis.

Gross pathology. Pathology No. 12,851. The specimen consists of part of the right, the median, and part of the left lobe of the thyroid gland. Weight 30 grams. The capsule is thin and shows no adhesions. On section, the surface is lobulated, translucent, and of a pinkish gray color. In the center of the right lobe, there is a nodule 3 millimeters in diameter, soft, opaque, grayish in color, and is indefinitely circumscribed. The left lobe shows a similar nodule. These nodules suggest small fœtal adenomata but the microscopic section shows that they are tuberculous foci. Further section of the gross gland demonstrates more of these structures which are tuberculous on microscopic examination.

Microscopic examination. The microscopic section shows a lobulated structure. In the stroma, especially near the capsule where the follicles are flattened, there are accumulations of small round cells with no definite germinal center formation. The follicles are small, well filled with deeply staining colloid, and are lined with a flat epithelium. Scattered throughout the section, there are follicles from which the colloid has disappeared and the lumina are filled with desquamated cells. Some follicles contain colloid which is thinned for some distance around the exfoliated cells. Other follicles

contain structures suggesting giant-cells, or exfoliated epithelium attached to clumps of colloid, and also cells that appear, microscopically, not unlike epithelioid cells.

The opaque nodules; which in the gross suggest fœtal adenomata, are histologically made up of giant-cells, epithelioid cells, and round cells. The giant-cells have multiple nuclei with a thin diffuse chromatin, which stains moderately deeply, and also an area of granular eosin-staining material. Scattered throughout the tuberculous process are the epithelioid cells with pale nuclei, irregular in shape and size, containing very little chromatin, and not associated with a definite cell-body. The small round cells, with deeply staining nuclei without definite cell-bodies, are numerous around the areas of epithelioid cells. Within the areas of the tuberculous process, there are entire follicles filled with colloid and surrounded by cuboidal epithelium, showing that the process has advanced faster than absorption and replacement of the normal tissues has taken place. At the edge of the process the inclusions of the colloid are more numerous; and at the very edge, there is an epithelioid cell formation and an accumulation of round cells in the stroma. Hence, the process seems to be of an advancing type, rather than a quiescent type, of tuberculosis.

CASE 9. Clinical diagnosis: goiter, exophthalmic. White female, age 32, housewife, complained of nervousness of four months' duration. The patient had had the usual childhood diseases, and since then had been in good health. The cardio-respiratory history was negative. About four months ago, while working very hard, the patient noticed that she became unusually nervous and very irritable, a condition never noticed before this time. There was palpitation and extreme coughing spells which often ended in vomiting. One month later, the patient had frequent crying spells; her menstrual flow became scanty; and she lost weight. These symptoms, with associated muscular weakness, increased steadily; the patient consulted her physican three weeks before entry into hospital, and was told that she had a goiter.

Physical examination. The patient was flushed and nervous. There was no exophthalmus or eye signs except a positive Stellwag's sign. The tonsils were enlarged. Moist rales were heard over the upper backs. The heart was enlarged to the left. There was a slight substernal dullness. There was a moderate enlargement of both sides of the neck, and a systolic murmur heard over the thyroid gland.

Operation. Five days before the removal of the thyroid gland, the right superior thyroid artery was ligated. The operation, uncomplicated by technical difficulties, consisted of the partial resection of both lobes. Postoperative course, uneventful; patient left hospital in 27 days markedly improved.

Pathological diagnosis: hyperplasia with adenoma and tuberculosis.

Gross pathology. Pathology No. 12,904. The specimen consists of the right and the left lobes of the thyroid gland. Weight 56 grams. On section the tissue cuts with resistance. The tissue is firm, rubbery, lobulated, reddish gray in color, and quite vascular. There are a few colloid retention cysts in some parts of the gland, and in other parts, there are areas about 5 millimeters in diameter which are nonlobulated, slightly encapsulated, and contain a yellowish crystalline deposit. The gland shows a definite hyperplasia.

Microscopic examination. The microscopic section, taken at random from the gland, shows an increase of stroma, an increased vascularity, and an occasional small round-cell accumulation. The follicles are very irregular in shape and size; they contain little or no eosin-staining material; they show occasional infoldings of the lining layers; and they are lined by a low, flat, a cuboidal, or tall columnar epithelium. Some areas are made up of great masses of small follicles. The active hyperplasia is very irregular in distribution. No tumors are made out.

In one field of the section is a conglomerate mass of tubercles, made up of a peripheral round-cell infiltration, numerous multinucleated giant-cells with areas of necrosis, and a central area of granular necrosis. The giant-cells are distributed about the central area of necrosis. Many epithelioid cells are seen among the giant-cells making up the tubercle. This mass of tubercles is in an area of fairly marked hyperplasia.

The histological picture of tuberculosis is noted in only a few sections. Many sections were made from areas which were suggestive of tuberculosis in the gross but which, microscopically, failed to show a tuberculous process. Some sections showed small conglomerate masses of tubercles.

CLINICAL DISCUSSION

The age incidence of the 9 cases is 33 years, the youngest being 18 years and the oldest (patient with malignancy and tuberculosis) 60 years. The average duration of goiter in the cases reported is fifteen months; and the longest duration of goiter was sixteen years. One patient had not noticed goiter at all. Nervousness was complained of by 7 patients, the shortest duration being two months and the longest seven and one-half years. Seven patients complained of palpitation; 3 had dyspnœa, 1 having had it for eight years. Two patients had exophthalmus; 2 gave a history of tuberculosis; and 3 had pleurisy. Fainting spells had been present in 3 cases.

On physical examination, 6 patients had enlarged hearts; 1 had a friction rub at the left lower back; 2 had exophthalmus; 7 had a marked tremor; and 6 showed a loss of weight

during the past year. The average blood-pressure of the 9 cases, on admission, was 145 millimeters mercury; on discharged was 129 millimeters of mercury. Four patients had had treatment (?); 2 had had rest; 1 had had digitalis; and 3 had had iodine, in 1 case applied locally.

The operation on all patients was a partial resection of the right, median, and part of the left lobes of the thyroid gland. Two patients had a ligation of one of the superior thyroid arteries, this giving an index of the clinical severity of the disease.

All but two of the cases were diagnosed clinically as "exophthalmic goiter." Cases 2 and 3 being diagnosed "mild exophthalmic goiter." Case 4 was diagnosed "sarcoma," clinically; Case 8 was diagnosed "hypertonus." It is remarkable that in no case was tuberculosis of the thyroid gland mentioned in the clinical diagnosis, nor was tuberculosis suspected in the gross specimen after operative removal.

GROSS MATERIAL

On going over a tabulated list of the findings of the glands in the gross, it was noted that the average weight of the thyroid tissue removed was 54 grams. Of the nine glands removed, five showed a diffuse and more or less symmetrical enlargement of both lobes, while four had tumors of various sizes and types. Three of the tumorous glands contained congenital adenomata, while one gland was made up of sarcomatous degeneration. In no gland was the tuberculous process recognized as such at the time of removal. Not until histological sections had been made was the true pathological condition comprehended, and even then in two of the cases the areas could not be located in the gross but only found microscopically by cutting numerous blocks from suspicious areas. Five of the nine specimens showed a more or less irregular hyperplasia, two of which contained adenomata. Two specimens of the nine cases reported were colloid goiters.

According to the reported cases of tuberculosis of the thyroid gland which were removed at operation, only the abscesses and large caseous, nodular, or conglomerate types have been recognized at operation or from the gross specimen. In the 3 cases reported by Ruppanner, the diagnosis was not made until the microscopic examination of the tissues had been completed. The author has found no reference to a malignant tumor associated with tuberculous infection of the thyroid gland.

HISTOLOGICAL DISCUSSION

For the absolute diagnosis of tuberculosis in the tissues, it is necessary to demonstrate in that tissue the tubercle bacillus. This may be attempted by the staining of the tubercle bacilli in the sections of the tissues, or by a digestion of the tissues by the antiformin method and a demonstration of the bacilli by subsequent staining. Both methods have been applied for the demonstration of tubercle bacilli in thyroid tissue. The earlier investigators, using the method of staining bacilli in sections, could not demonstrate tubercle bacilli with any degree of regularity in histological tuberculosis of the thyroid gland. E. Fraenkel, after a careful search for the organism in the thyroid glands removed at autopsy, said that tuberculosis of the thyroid usually showed itself by a richness of giant-cells and a lack of tubercle bacilli. In only one of his three cases was Ruppanner able to demonstrate the bacilli. Schiller diagnosed a case of acute tuberculosis of the thyroid gland by the cystic tumor of the neck. In this case the tubercle bacilli were demonstrated. Roger and Garnier found many tubercle bacilli in a thyroid gland removed from a gravid who had an associated tuberculosis of the pharynx. Halstead did not find the organism in the case of thyroid tuberculosis which he reported. After a thorough search of the sections for tubercle bacilli, Lediard was unable to demonstrate them. Hedinger has been fortunate with the antiformin method. According to his report of 10 cases, including the 3 cases reported by Ruppanner, in only 1 of which bacilli had been demonstrated, Hedinger was able to demonstrate to his own satisfaction, even when finding only a single bacillus, tubercle bacilli in all but 1 of the 10 cases. By the antiformin method, the author has been able to isolate granular, shrunken, acid-fast structures from tuberculous tissue, which

could easily be taken for tubercle bacilli, but they were too greatly distorted to be positive proof of the presence of the bacillus.

Many of the cases of tuberculosis of the thyroid gland that have been reported, either from the material at autopsy or from the operative clinic, have been diagnosed from the microscopical histological picture in spite of the lack of tubercle bacilli findings. Perry and Voelcker, reporting 4 cases in children, make the diagnosis by the microscopical histological picture. Ruppanner could demonstrate bacilli in only 1 of his 3 reported cases, and he expresses the belief that the diagnosis can be made from the histological picture without the demonstration of the bacilli. In spite of the fact that Lediard could not demonstrate tubercle bacilli in the sections, and that cultures from the abscess cavity remained sterile, and that smears stained for organisms gave negative results, he made the following statement: "In spite of the non-recovery of the tubercle bacilli, the histological picture is typical of tubercular disease, and there can be no question of the nature of the disease." Corner expressed the idea that the tissues taken from the abscess wall of the thyroid in his case showed chronic inflammation and numerous tubercles. Hedinger thinks that, "In spite of the negative findings for bacilli, from a sure and satisfactory histological picture one can make a positive diagnosis of tuberculosis." Halstead, Arnd, Pupovac also have made the diagnosis of tuberculosis of the thyroid gland from the histological picture without the demonstration of tubercle bacilli. In the author's cases, the histological picture was taken as the diagnostic characteristic. The demonstration of bacilli, while necessary for the absolute diagnosis, is an ultimate refinement which is seldom used in the general work of a pathological laboratory where the histological picture is taken as evidence of tuberculosis. Three of the reported cases showed areas of tumor formation in the gross. The fact that in these 3 cases the tuberculosis process was noted, histologically, only in the compressed fibrous tissue about the adenomata, is in agreement with the statement made by Ruppanner that the tuberculosis is to be found in the non-tumorous portion of the gland. In no cases were tubercles found in the adenomatous areas, in spite of the fact that the adenomata were not always of the colloid type.

Ruppanner was among the first investigators to divide the location of the tuberculous lesion in the thyroid gland into interfollicular and intrafollicular types. The interfollicular is by far the more common of the two types, and it is, in histological structure, not unlike the tubercle in other glandular organs; but, in the intrafollicular type, the picture is somewhat different. In a hyperplasia of the thyroid gland, it is not unusual to see an interfollicular giant-cell, but the nuclei of these giant-cells stain with the same intensity as those of the follicular epithelium, and the space about the giant-cell is not filled with cells that have irregular nuclei. In a section taken from a thyroid gland that has well defined interfollicular tubercles, there are not unusually giant-cells with an area of necrosis and occasionally engulfed colloid, which have nuclei that stain more faintly than do the nuclei of the remaining parts of the follicular epithelium. Then, too, the space about the giant-cells in these intrafollicular structures is usually occupied by cells that suggest epithelioid cells. Still another point is the fact that the intrafollicular tubercles are present in the adenomatous goiter and not in the hyperplastic gland. Ruppanner demonstrated tubercle bacilli in these intrafollicular giant-cells. To be sure that the intrafollicular giant-cells are associated with tuberculosis, the presence of the bacillus must be demonstrated. The report of Hedinger, coming from the same laboratory as that of Ruppanner, states that he did not observe tuberculosis in the follicles without its involving the stroma also. Two of the specimens of this series show the intrafollicular type of tubercle.

The presence of lymphoid tissue in the thyroid gland has been a much discussed subject. DeQuervain thought that the increase of connective tissue, the proliferation of the epithelium, and the lymphocytic infiltration might be due to the tuberculous process or the result of a mixed infection. After study-

ing the material from the clinics of Basel and Bern, Hedinger was impressed with the increased number of cases showing lymph-follicle formation with germ centers in the Basel material. Here also, there was more tuberculosis of the thyroid gland. A. Kocher, after studying the thyroids removed at operation, came to the conclusions, that lymphoid tissue was more common in glands that showed desquamation; that the presence of round cells might be a reactionary or an inflamatory process; and that the areas of cellular infiltration are always made up of lymphocytes and not pus-cells, and are occasionally found in glands with little or no desquamation, and also in glands that are said to be "healed." Von Werdt, after examining 80 cases with marked lymphoid formation in the thyroid gland, found that only 6 cases had not used iodine, which was usually applied locally in the form of an iodine salve. Nine cases who used iodine did not show lymphoid formation, while 6 that did not use iodine had lymphoid tissue in the thyroid gland. Atrophy, due to (1) iodine, applied locally; (2) pressure, as from adenomata; and (3) bacterial toxic influences, as in tuberculosis, are given by Von Werdt to be the main causes of lymphoid tissue formation in the thyroid gland.

Of the cases here reported, all had more or less lymphoid tissue formation. Case 1 showed definite lymph-follicle formation with germinal centers; Cases 2, 3, 4, and 5 showed rather diffuse round-cell infiltrations; and Cases 6, 7, 8, and 9 showed only an occasional accumulation of lymphocytes. Cases 1, 4, 6, and 7 had had treatment; Case 1 had had liquid medicine (?) and tablets (?); but only Cases 4 and 6 gave a history of using iodine. In these cases, there is no definite relationship between the application of iodine and the lymphoid tissue found in the gland.

GENERAL DISCUSSION

Of the cases here reported, Case 1 was the only male in the series. In the family of one patient, Case 5, were several "scrofula" members; while another patient, Case 7, lived in a home in which a relative had died of "consumption of years duration." Three patients, Cases 2, 6, and 7, gave a history of repeated attacks of pleurisy. On general physical examination, Cases 1, 5, and 7 showed numerous enlarged lymph-glands, especially cervical and axillary. When realizing the extent of tuberculous disease, the negative history and physical examinations of the other two cases does not exclude the possibility of an old primary focus of the disease. Hence, it is doubtful if there is a true primary tuberculosis of the thyroid gland. Arnd was unable, in the three cases that he reported, to exclude by the clinical history or by the physical examination the possibility of a primary focus for the entry of the tubercle bacillus.

Since tuberculosis was not recognized in the gross glands, and only located microscopically more or less accidentally, there are, no doubt, many cases of tuberculosis of the thyroid which would have been recognized if the glands could have been completely sectioned. The 9 cases here reported comprise a tuberculous involvement of less than one per cent of the operative material removed at the Crile Clinic; however, this percentage would no doubt be higher if it were practical to examine histologically the whole gland.

SUMMARY

From the earlier pathological writings, one is impressed with the idea that the thyroid gland is immune from the attack of the tubercle bacillus. As autopsy reports began to accumulate, it was found that in acute miliary tuberculosis the thyroid gland did not escape infections. Tuberculous abscesses and conglomerate masses of tuberculosis in the thyroid gland began to attract the surgical attention and developed the idea of a primary infection of the thyroid gland. As the operative material increased, tuberculosis of the thyroid gland was occasionally found histologically, but it was practically never recognized in the gross. The tubercle bacilli are very hard to find in the histological sections, and the diagnosis is not unusually made from the histological picture. Now that a larger operative material has been accumulated, tuberculosis of the thyroid comes in for a definite and important per-

centage of the pathological lesions that are found in the thyroid gland, and that percentage is even higher than has been shown by the pathological survey. Experimentally, the work of Shimadaria gave results which suggest a slight immunity of the thyroid gland in animals against the action of the tubercle bacillus. Primary tuberculosis of the thyroid gland, which is established with difficulty, is an unusual finding, and most of the evidence suggests that the lesion in the gland is secondary to some healed or unhealed primary focus. The tuberculous process is associated with various physiological and pathological changes in the thyroid gland as, hyperplasia, pure colloid goiter, adenomatous goiters, sarcomata, or any combination of the before named conditions.

The author wishes to thank Dr. George W. Crile for the opportunity to report the above material from the Crile Clinic, and wishes to express his appreciation for helpful suggestions from Dr. David Marine and Dr. Allen Graham.

BIBLIOGRAPHY

ADAMI and NICHOLLIS. Principles of Pathology. 1911, vol. ii.

ARND. Beitraege zur Klinik der Schilddruesen tuberkulose. Deutsche Ztschr. f. Chir., Leipz., 1912, cxvi, 7.

BÉRARD. Corps thyroide, goitres etc. in LeDentu et Delbet. Nouveau Traite de chir. Paris: 1908.

BERRY. Tr. Path. Soc., Lond., xli, 261.

BIRCH-HERSCHFELD. Lehrb. d. spez. path. Anat., 1895, 4th ed.

BRUNS. Struma tuberkulosa. Beitr. z. klin. Chir., 1903, x.

CASTAIGNE and GILBERT. Goiter exophthalmique et tuberculose de la glande thyroide. Bull. Soc. de biol., 1899, vi, No. 3.

CHIARI. Ueber Tuberkulose der Schilddruese. Wien. med. Jahrb., 1878, 68–75.

CLAIRMONT. Zur Tuberkulose der Schilddruese. Wien. klin. Wchnschr., 1902, No. 48.

COHNHEIM. Ueber die Tuberkulose der Choriodea. Arch. f. path. Anat., etc., Berl., 1867, xxxix.

CORNER. Primary and secondary local tuberculosis of the thyroid gland. Tr. Clin. Soc., Lond., 1903, xxxviii, 112.

CORNIL and RANVIER. Manuel d'Histologie pathologique. Paris: 1876.

DACOSTA. Modern Surgery. 1911, p. 1227.

DEMME. Krankheiten der Schilddruese im Handbuch der Kinderkrankheiten von Gerhardt. Tuebingen. 1878, iii.

DEQUERVAIN. Thyroiditis simplex und toxische Reaktion der Schilddruese. Mittl. a. d. Grenzgeb. d. Med. u. Chir., 1905, xv.

DUMORLARD. Contribution a l'histoire de la strumite. Lyon méd., 1879, No. 44.

DUTOIT. Die Schilddruesentuberkulose. Deutsche med. Wchnschr., 1913, xxxix, 227.

FRAENKEL. Ueber Schilddruesentuberkulose. Arch. f. path. Anat., etc., Berl., 1886, civ, 58.

GIERKE. Path. Anatomie. Jena: 1909, ii.

GASSET and ESTOR. Myelite cervicale etc., thyroidite tuberculose. Rev. de méd. 1887, Feb. 10.

HALSTEAD. Tuberculosis of the thyroid gland with case report. Internat. Clin., Phila., 1910, p. 120.

HEDINGER. Zur Lehre der Schilddruesentuberkulose. Deutsche Ztschr. f. Chir., 1912, cxvi, 125.

KASHIWAMURA. Die Schilddruese bie Infectionskrankheiten. Arch. f. path. Anat., etc., Berl., 1901, clxvi.

KAUFMANN. Lehrb. d. spez. path. Anat., Berl., 1909.

KOCHER, A. Ergebnisse histologische und chemische Untersuchung von 160 Basedowfallen. Arch. f. klin. Chir., 1910, xcii, 442.

LEMORANT. Tuberculose du corps thyroide a propos d'un absces froid thyroide. Prögrés méd., 1908.

LEDIARD. Primary tuberculosis of the thyroid. Tr. Path. Soc., Lond., 1905, lvii, 153.

PERRY and VOELCKER. Tuberculosis of the thyroid gland. Tr. Path. Soc., Lond., 1890, xlii, 298.

PUPOVAC. Zur Kenntnis Tuberkulose der Schilddruese. Wein. klin. Wchnschr., 1903, xvi, 1012.

RIBBERT. Spez. Path. und spez. path. Anat. Leipzig: 1896.

RINDFLEISCH. Die Elemente der Pathologie. Leipzig: 1896, 3d ed.

ROGER and GARNIER. Des lesions de la glands thyroide dans la tuberculose. Arch. gén., de méd., 1900, clxxxv.

ROKITANSKI. Lehrb. d. path. Anat., vol. iii.

ROLLESTON. Tr. Path. Soc., Lond., 1896, xlviii, 197.

RUPPANNER. Ueber tuberkulose strumen; ein Beitraege zur Kenntnis der Schilddruesentuberkulose. Frankf. Ztschr. f. Path., 1908, ii, 513.

SCHILLER. Kalter Abscess in der Glandula thyroide. Wien. klin. Wchnschr., 1908, No. 30.

SCHMAUS. Grundness d. path. Anatomie. 1907, 8th ed.

SCHWARTZ. Arch. internat. de laryngol., etc., Par., 1894, vii, 320.

SHIMODIARA. Experimentalle Untersuchungen ueber die tuberkulose infection der Schilddruese. Deutsche Ztschr. f. Chir., 1911, cix.

TOMILLINI. Experimentalle Untersuchungen ueber die Tuberkulose der Schilddruese. Beitr. z. path. Anat. u. z. allg. Path., Jena, 1905, xxxvii, 590.

TORRI. La tiroide nei morbi infettiosi. Policlin., Roma, Sez., Chir., 1900, p. 145.

VIRCHOW. Die Krankhaften Geschwulste, vol. xxii.

V. WERDT. Ueber lymphfollikelbildung im Struma. Frankf. Ztschr. f. Path., 1911, viii.

ZIEGLER. Spezielle Pathologie. Jena: 1901.

PARTIAL GASTRECTOMY IN THE TREATMENT OF CHRONIC INDURATED ULCERS OF THE STOMACH[1]

By DR. L. SIERRA, Santiago, Chile
Professor of Clinical Surgery, University of Chile; Surgeon, Salvador and St. Berja Hospitals

I APPRECIATE the great honor that has been conferred upon me by an invitation to read a paper before this brilliant congregation of the ablest surgeons of a nation so prolific in men who specialize in this science. I am well aware that there is nothing new nor interesting that I can offer to this assembly, but I have accepted the invitation to address you as I wish to take advantage of this opportunity to give testimony as to all that I owe in my medical education to such men as Fenger, Coley, Hartley, McCosh, Bull, Halsted, Welch, T. Smith, Murphy, Rosenow, Keen, Crile, and most particularly to that famous school conducted by the Mayo brothers at Rochester, Minnesota.

Although I have visited the best European clinics and have had the honor of meeting personally Kocher, Depage, Hartmann, Mikulicz, Trendelenburg, Eiselsberg, and Riedel, I am a firm believer in the teachings of the Rochester school concerning gastro-abdominal surgery. The constant reading and the translation into Spanish of many of the papers from the clinic and the knowledge gained from two visits to St. Mary's Hospital have convinced me that the teachings of the Mayo clinic must inspire each of us who loves his art. From this school I have learned in what an enormous percentage of cases indurated ulcers of the stomach degenerate into cancer, and I extend to the brothers Mayo (2) and to Rodman (3) due credit for the impulse which has prompted me to advocate in my country the radical treatment of this lesion.

The first pylorectomy was performed in Chile twenty years ago. Later on, whether through lack of ability to diagnose the condition or the means to arrive at a diagnosis; whether the people were indifferent in regard to seeking treatment for such conditions or whether it had become an accepted notion among our physicians that cancer of the stomach was incurable, the surgical profession was reduced to the mere surgery of traumatisms, wounds, and some of the palliative operations. The very poor results following operations for gastric cancer contributed to maintain the vicious circle in which this branch of surgery was involved. The patients were all operated upon late.

If it is possible to cure by gastro-enterostomy duodenal ulcers in which malignant degeneration is an exception, will not the same operation produce the same results in similar lesions when located in the vicinity of the pylorus? In many cases, even with abdomen open, it is impossible to determine whether we are in the presence of an ulcer or of a cancer (Kuettner, 4). If gastro-enterostomy is done to cure gastric ulcer, one still is not sure that hæmorrhage, subphrenic abscess, or the fearful cancerous degeneration will not occur. It is for these reasons that I advise and perform gastrectomy in those cases in which the general condition of the patient permits. After some experience with the methods of Billroth I, Billroth II, and gastroduodenostomy (Kocher), I have adopted and use the operation of Polya (5) as is described and recommended by W. J. Mayo (6).

I have performed this operation six times in the last thirteen months and have lost but one patient, an American woman who had suffered from gastric symptoms ever since she had been in the Philippines about six years before. She had become extremely emaciated. Incidentally, I will remark that in my country it is only the private patients who come late for operation. In some cases a voyage to Europe to consult specialists precedes the operation. Kuettner, working in the cradle of European gastric surgery, in the school of Mikulicz, makes exactly the same observation.

In all our patients the clinical manifestations of the disease have arrived at such an

[1] Read by title before the Clinical Congress of Surgeons of North America, Philadelphia, October, 21-26, 1916.

advanced stage that it is useless to lose further time in laboratory examinations. It is absolutely certain that no other procedure than operation is possible in order to help these cases. We are following in that respect the ideas of B. B. Davis (7); that is, that cancer is even more of an emergency disease than is appendicitis. Furthermore, like Kocher, Paterson and others, I am convinced, that in those cases it is more dangerous to wait than to operate. If, in accordance with the opinion of E. Owen, it is an accepted fact that in doubtful cases of appendicitis, laparotomy should be done to determine the nature of the disease, why should we hesitate to employ the same method to establish our diagnosis in the upper abdomen? The exploratory laparotomy is still, in my country, the sovereign criterion to determine the procedure of the surgeon. Only some weeks ago I opened the abdomen of an old lady who had had gastric symptoms for many years. I was able, because the patient was extremely emaciated, to detect on many occasions a tumor no larger than a small nut. The operation revealed a gall-stone in the common duct. I was not ashamed at all of this error, because I was able to help my patient.

Tumor was palpable, very easily palpable in all of our patients. I know quite well that induration of an ulcer may be present in a very few weeks; and I do not ignore that the beautiful work of Mr. A. Thomson (8), Bird, and others who have shown that an extensive fibromatosis of the stomach may have no relation to cancer. When in doubt, I give my patients the benefit of an operation. The indirect operation, as Mr. Bland-Sutton (9) insists, is an operation of another epoch, because the disease remains and threatens the patient with its complications.

W. J. Mayo and Bland-Sutton have called attention to the influence of sepsis and the appearance of the patient, indicating that they are suffering with cancer. The anæmic appearance and the peculiar aspect which they present are in a great proportion of cases due to sepsis. In such patients it may be justifiable to follow the plan proposed by H. Paterson (10, 14), begin with gastro-enterostomy and if the patient cannot tolerate further intervention, omit the second operation.

I followed this advice in the case of an extremely emaciated patient, who was terrified at the thought of a second operation. Following the practice of B. Dawson (11) and Mayo, I ordered the patient to be most scrupulous in the care of his mouth which showed much to be desired in this direction, and following the principles of anoci-association of Crile, I was able to do what I do not hesitate to call an ideal gastro-enterostomy. The result has been so good that the patient refuses to consent to a second operation; he seems to be quite well. The greatly indurated pyloric mass is still there, pressing upon the biliary channels, but after all it can be, and I hope that it is, no more than a fibromatosis which has developed in the vicinity of an indurated chronic ulcer.

In Chile, we are far behind in the brilliant results obtained in North America with the X-rays for the diagnosis of these lesions. We have not yet a uniform technique for their application. We have endeavored to introduce the direct method of L. G. Cole, so beautifully followed in the most complete work of George and Leonard (12).

I have not yet had the opportunity to discover in my patients the secondary deposits in Douglas' pouch to which G. G. Turner and Dr. Palmer (13) have called attention. In some of our patients we have found the supraclavicular gland of Troissier-Virchow enlarged, and I have refused to operate upon these cases.

SUMMARY

Up to the present time in Chile, we rely upon exploratory laparotomy as the final step in determining whether an indurated chronic ulcer (15) of the stomach should be treated by the indirect operation or by the most radical and rational method; that is, gastrectomy. We are in this respect a little in the same position as the English surgeons were in 1911 (14). I am a decided partisan of gastrectomy and all my preferences go to the operation introduced by Polya and recommended by W. J. Mayo.

REFERENCES

1. Mathieu, Sencert, and Tuffier. Maladies de l'estomac. Paris: 1913, p. 672.
2. Collected Papers, Mayo Clinic, 1914.
3. Rodman, W. L. Surg., Gynec. & Obst., 1915, xx, 25.
4. XLIII Kong. deutsch. Gesellsch. f. Chir., 1914.
5. Stumpfersorg. nach Magenresection. Zentralbl. f. Chir., 1911, ii, 892.
6. Collected Papers, Mayo Clinic, 1914, p. 115.
7. Team work. Surg., Gynec. & Obst., 1915, p. 676.
8. Brit. M. J., 1910, ii, 949.
9. Brit. M. J., Hunterian Lecture, 1916, p. 772.
10. Nisbet. Surgery of the Stomach, 1913.
11. Brit. M. J., 1912, ii, 940.
12. The Roentgen Diagnosis in Surgical Lesions. Boston; The Colonial Press, 1915.
13. Brit. M. J., 1914, i, 229.
14. Brit. M. J., 1911, i, 1459.
15. Faulhaber and Redwitg. Zur Klinik und Behand. lung des "pylorusfernen" Ulcus ventriculi. Mittl-a. Grenzgeb. Med. u. Chir., 1914, xxviii, 151.
16. Makins. Diagnosis and treatment carcinoma of stomach. Brit. M. J., 1913, vii, 1059.

CONGENITAL RADIO-ULNAR SYNOSTOSIS

By WILSON WELLINGTON FEIDT, M.D., Minneapolis, Minnesota
Assistant Surgeon, Minneapolis City Hospital

CONGENITAL synostosis of the upper ends of radius and ulna is of rare occurrence and shows a tendency to follow certain laws of heredity. In some 40 cases reported to date, only 1 case was reported as successfully operated upon, with restoration of the function of supination of forearm. A perfect result was obtained in this case only after a series of five operations.

In this type of deformity there usually occurs in both forearms from three to six centimeters of intimate union of the upper ends of both bones, and the power of supination is largely obtained through the muscles of the arm and shoulder. In view of the foregoing facts, conservative treatment is of no value, regardless of how early the conditions may have been recognized by the surgeon, as even at birth the union is of such a consistency as to be beyond conservative measures.

This condition has received very little attention in this country and no cases have heretofore been reported by American surgeons. This report includes two cases, occurring in my service in the Minneapolis City Hospital, mother and daughter, both natives of Russia, and very much alike in gross appearance and loss of function. The mother informs me that her father also, a teacher in Russia, had the same deformity.

Heredity. Regarding the strong hereditary tendencies, it is interesting to note that in Abbott's (1) cases the deformity was met with seven times in five generations; Blumenthal (2) reports it also present in a young sister, the father and the paternal grandmother of his patient; in von Sury's (3) cases the patient's sister, mother, and maternal grandmother were similarly affected.

I would here call your attention to a most striking tendency to heredity in the human as shown by Cushing (4), who has published a series of 302 individuals in which congenital ankylosis of the proximal phalangeal joints occurred, with 25.8 per cent of these in one family.

As the two conditions are of the same character, a bony union of a joint in the upper extremity, it gives us strong presumptive evidence of the hereditary tendencies in radio-ulnar synostosis. This brings us to Mendel's law. Cushing's study through seven generations proves conclusively that this trait may be transmitted in its most outspoken form by a parent who appears to be slightly affected, but never through parents both of whom are unaffected. His conclusions were that the trait behaves as a simple Mendelian dominant, with equal chance among the offspring of affected individuals, that it will or will not be inherited.

It is quite probable that these conclusions are applicable to radio-ulnar synostosis.

Clinical features. I am certain that the deformity is often overlooked by the clinician; however, since the introduction of the X-ray

as an aid in the surgical diagnosis its discovery is more frequent and it removes all doubt in its diagnosis. Textbooks do not even mention the condition, which accounts for the lack of interest by the medical profession. The prominent clinical features in such cases are the inability to supinate the forearm, the natural position of the hand being in pronation, also the inability to lift objects of any weight. The patient is continually dropping objects, and cannot receive articles in the palm of the hand, for example, a coin. Supination is done very largely by the action of the muscles of the arm and shoulder. This gives an awkward, twisted movement of the whole upper extremity. They are unable to take part in most athletics, and in wringing water out of a cloth the twisting power is weak and quite useless. The condition is known to exist from birth, and the subjects feel their defect quite keenly, and are loath to draw attention to the condition.

Movements at the elbow-joints are as follows: flexion normal, while extension usually is not quite maximal; the wrist-joint movement is normal. On examination of the arm, the upper posterior lateral sulcus corresponds to the position of the receded head of the radius.

On examination of the shaft of the radius, which is much enlarged, we note an effort of nature to preserve the lower wrist-joint action by bending the radius outward, making a wider interosseous space than normal. This bent-club appearance of the radius is quite noticeable in both cases here reported. That the osseous union of the radius and ulna is firm can easily be proved by X-ray plates, as well as by the test of forced supination.

Morbid anatomy. There are two types of this deformity. (1) True radio-ulnar synostosis in which the upper end of the radius is fused with the ulna for 3 to 6 centimeters. This bony union is intimate, with no intervening compact layer between the spongiosa of the radius and ulna. Blodgett (5) describes this "cancellated bone fusion" as important in the cause of this deformity. Longuet and Peraire (6) describe by the term *ossification arciforme* the line of fusion extending obliquely downward on the front of the ulna; and its lower end usually has an arcurate to correspond to the upper limit of the interosseous membrane.

Roskoschny (7) reverses the usual arrangement in reporting a case in which the ulna was stout and long and the radius slender and short. Appraille (8) describes a single case of synostosis of the lower end of the ulna and radius. The lower end of the radius and ulna are usuallly free. Wilkie (9) cites a case of lower end thickening of radius and ulna, which he describes as "a symmetrical thickening," and suggestes there is a tendency to a fusion of the lower ends as well as of the upper ends of these bones. In Case 2, here reported, the mother showed this symmetrical thickening, in both radius and ulna extending about 6 centimeters from the lower ends. Careful study shows that Case 1, the daughter, has these same features. In Case 2, there is a linear fissure of the external surface of the lower radius, leading to the wrist-joint, internal to the styloid process, which suggests some former injury, as a fracture. But this is denied in the history of the case. Its perfect symmetery in both radii would suggest that in her strenuous work there had occurred some tearing of the bony structure by muscular action, much as we would explain a spontaneous fracture in a pathological condition.

The fascial and muscular changes are apparent. The supinator muscles are deficient, and Dawson (10) reports a case in which the supinator brevis was absent. The axis of the flexors and extensors is altered and the pronators radii teres and quadratus are shortened. The interosseous membrane is usually narrowed in its upper part.

2. Synostosis with dislocation of the head of the radius is the other type of deformity and is more frequently met with.

Etiology. Liebein (11) states that this deformity belongs to a group of deformities of the osseous system characterized by disturbance in osteogenesis in isolated and frequently symmetrical sites in the body, and that the defect, whatever it be, is transmitted in the germ-plasm.

This lack of, or delayed, development of the radius may be the late appearance of the

ossification center in the proximal end of the radius; hence it is possible that some inhibitory influence may be active at this prenatal period, which may determine or cause these congenital anomalies; and this is conceivably influenced by heredity.

In the embryo the usual position of the forearm is pronation but I have no cause to think that uterine pressure or any other factor would account for a solid and intimate union of these bones, as was recognized by this mother in this case here reported who detected the deformity herself and tried to correct it during the first week of the child's life.

Bardeen and Lewis (12) found in the embryo at four and a half weeks that the radius and ulna were distinct below, but fused above. Lewis (13) states further that at the sixth week of fœtal life the distal ends of the forearm bones were distinct and separated from each other, and that the perichondrium of the proximal end of the radius was continuous with that of the adjoining surface of the ulna. Lambertz law relating to these cases is as follows: In the extremities the ends which show a more elaborate development as regards shape have a less degree of growth; hence as the radius does not develop in form it seems to increase in length.

Treatment. There is in my mind no satisfactory treatment for a case of congenital synostosis of the upper ends of the radius and ulna.

Dawson's five operations on one patient with restoration of the function of supination was justifiable inasmuch as the patient was determined to get relief at all hazards. It is interesting to note that division of the bridge, freeing the head of the ulna, division of the interosseous membrane, excision of the head of the radius with rotation of the bone segment 40 degrees finally gave the young woman a very useful forearm.

It will be important to note that Dawson was successful after the osteotomy of the radius at the junction of the lower and middle third by rotating the lower fragment 40 degrees. He held this position by the use of plates. This gave free use of the forearm, as the patient could use the forearm in the turning movement, as in the use of the screwdriver or playing the piano.

It should be noted that Dawson's five operations were pioneer work and in great measure necessarily experimental, and that one of them, the freeing of the head of the ulna, accomplished no benefit. With the data gained from this case we can see that his four beneficial operations could be accomplished in one operation, that separation of the head of the radius and division of the interosseous memberane, with osteotomy and rotation of the radius, are all that is required for successful restoration of the function of supination.

Of the other five cases reported operated upon, the result in two was about 80 degrees rotation, as will be seen in the following table:

Operator	Where reported	Operation	Results
1. Kummel	Bibliot. méd. Abt. u. Chir., cxi, 19.	Bony bridge divided	Not known
2. Morestin	Bull. et mém. Soc. Anat. de Par., 1904, 60.	Removed head of radius and resected the bony bridge	80 degree rotation
3. Stretton	Brit. M. J., 1905, xi, 1519.	Division of bridge and resection of head of radius	Great improvement
4. Rais		Division of synostosis	Lack of improvement
5. Schilling	Inaugural Dissertation Kiel, ref. Lieblein, loc. cit.	Division of bony bridge and extensor carpi radialis interposed	78 degree rotation in two months

In the case of the daughter, here reported, I was asked to improve her condition by the use of braces; operation was not desired by either patient, as neither considered themselves sufficiently inconvenienced to expose themselves to operative procedures.

I wish to express my gratitude to Dr. Charles D. Harrington for these excellent radiographs.

CASE 1. Female, age 15, school girl. Nativity Russia. Came to hospital from gymnasium on account of deficiencies in arm movement. This impairment was first noticed by her mother when she was only a week old. The mother had made an effort to correct the deformity but failed. The patient knew her condition in childhood as she could not play jack-stones, and would let things drop, but was anxious to get along without being noticed in her defective movements. She can play the piano and do most things other children do, and at present is employed as a clerk in a department store. Here

Fig. 1. Case 1 (at left). To show natural position of forearm in pronation. Note the narrowed outline of upper forearms with well marked sulcus on postero-external aspect of elbow.

Case 2. Same position of pronation in the mother. To show characteristic contour of forearms. Wide lower forearm and narrow upper forearms. Note sulcus on postero-external aspect of elbow.

she is continually dropping articles. Had typhoid at eight and made a good recovery. Family history negative except mother has similar condition.

Examination. Muscular development of arms and forearms above the average. No marks or scars around elbow-joints. The contour of the forearms was quite distinctive. In the position of full pronation, her natural position, the narrow outline of the upper end of forearm, due to the receded head of the radius, was noticeable. In this position a sulcus is produced.

Outward rotation of the shoulder-joints gives a twisted position which makes possible the limited supination of the forearms. By special effort to rotate she secures a maximum amount of supination as follows: right 45 degrees, left 60 degrees, due mostly to action of the shoulder-joints. The palmar surfaces were approximated only by effort from the shoulder. Circumduction at the shoulder is not perfect, being impeded in full extension. The elbow-joint is not perfect, there being an extension of only 160 degrees. Flexion normal. Flexion and extension of wrist normal. In the act of taking a coin she rotates the forearm from the shoulder; in the effort to effect supination, to receive a coin, she must take it between the thumb and index finger, being unable to turn palm uppermost as is the usual way of receiving money or other objects. In the test of placing finger tips to chest with the dorsal surfaces of hands in apposition, the wrist forming an angle of 90 degrees, the best she can do is to place the hands on the chest in the awkward position shown in Figure 3. The roentgenograms show solid bony union of 6 centimeters of upper ends of radius and ulna. The

Fig. 2. Case 1 (at left). Maximum supination secured by rotating shoulder outward; the patient in act of grasping a coin.

Case 2. Maximum supination secured by rotating shoulder outward; the patient in act of grasping a coin.

shaft of the ulna is slender and straight, while the shaft of the radius is stout and curved, as if pushed away from the ulna, causing the interosseous space to be abnormally wide. There is a slight enlargement of ulna and radius for about 5 centimeters from lower ends. Both forearms are practically identical and there are no other abnormalities in the body. The grasping and lifting strength is practically lost with the arms in extension.

Case 2. Female, aged 42, house-wife. Nativity Russia. Mother of Case 1. Came to hospital with request that I give daughter relief of her deformity by use of braces. She knew her own condition and has always worked hard; when washing she had great difficulty in wringing the water out of clothes. She has very little twisting power in the forearms.

She is the mother of five girls and one boy, and after careful examination I was unable to detect any abnormality in any but the case reported above.

One especially interesting feature is that she reports that her father who died in Russia, aged 62 years, had the same condition. He followed teaching and was unable to supinate his forearms. The fact that for three generations this deformity existed is proof of its hereditary tendencies. In the two cases here reported their actions, deficiencies, and anatomical pictures are so similar that to report the mothers' case is a repetition of Case 1. She is very sensitive regarding her deformity and is superstitious about it.

Fig. 3. Case 1 (at left). Forearm in position in attempting to approximate dorsal surfaces of hands with wrist forming angle of 90 degrees.

Case 2. Forearms in position same position as in Case 1.

Fig. 4. Roentgenogram of Case 1.

Fig. 5. Roentgenogram of Case 2.

Examination. Muscular development of arms and forearms unusually large. There are no traces of former injury or disease in the neighborhood of the elbow or wrist-joints. The sulci due to retraction of the heads of the radii are very noticeable. This also gives the narrow outlines of upper forearms.

Outward movement from shoulder action gives about 55 degrees of supination of both forearms. Circumduction of shoulder-joints impeded at full extension.

Extension of elbow-joints is 160 degrees. However, flexion of elbow-joints is normal. The wrist actions of flexion, extension, and outward and inward rotation are normal.

In her action of receiving a coin she shows the same awkward movement of twisting the whole upper extremity from the shoulder. This same awkward movement is again shown in the chest position.

In the radiographic study we notice the same general landmarks as in Case 1. However, in a close study, there are interesting differences. Union of upper radio-ulnar 5 centimeters or 1 centimeter less of union than in Case 1. The union is firm and makes a solid upper forearm and there is no outward rotation from the upper radio-ulnar articulation. The outer edge of ulna is unusually straight and there is a thickened outline of the lower 6 centimeters of ulna. The radius appears pushed away farther from the ulna than in Case 1, thus forming a wider interosseous space. The irregularly enlarged (club-like) appearance of the lower end of the ulna and radius is interesting, as compared with the smooth outline of the lower end of the ulna and radius in Case 1. Again, it will be noticed that the synostosis in the right and left forearms is identical and the patient suffers the same lack of function in both arms.

REFERENCES

1. Abbott. Tr. Path. Soc. Lond., 1892, xliii, 129.
2. Blumenthal. Ztschr. f. orth. Chir., 1904, xii, 181.
3. Von Sury. Cor.-bl. f. schweiz. Aertz., 1909, xxxix, 79.
4. Cushing. Genetics, i, No. 1, 90.
5. Blodgett. Am. J. Orth. Surg., 1906, xiii, 253.
6. Longuet and Peraire. Bull. et mém. Soc. anat. de Par., 1901, 147.
7. Roskoschny. Deutsche Ztschr. f. Chir., 1905, lxxvi, 568.
8. Appraille. These de doct. de Par., 1901; ref. Zentralbl. f. Chir., 1901, p. 1066.
9. Wilkie. Brit. J. Surg., 1913, i, 366.
10. Dawson. Brit. M. J., 1912, ii, 833.
11. Lieblein. Ztschr. f. orth. Chir., 1909, xxiv, 52.
12. Bardeen and Lewis. Am. J. Anat., 1901, i, p. 1.
13. Lewis. Ibid., p. 145.

THE GROWTH OF FREE BONE TRANSPLANTS

An Experimental Study

By Dr. TSUNEHARU TODYO
Instructor in the Orthopedic Clinic of the Imperial University, Kiushiu, Japan

OLLIER'S view (23) that "bone transplanted with its periosteum can survive" was overthrown when Barth (6) advocated that according to his experiments transplanted bone entirely loses its vital power and is replaced by newly built bone tissue. Therefore, it would seem that dead or living bone transplants may be used without altering the process of bone regeneration. Since then the consensus of opinion is that the fate of the transplanted bone is not so extreme as Barth declared. The bone tissue should be kept covered with its periosteum preferably as fresh as possible and autogenous transplants should always be used to attain the best results in bone transplantation.

While the question of the fate of transplanted bone and the problems associated with it are not quite settled, the use of bone transplants is increasing year by year, and is fulfilling its clinical aim. The cases of Prof. Dr. Sumita, which he published in the transactions of the fifteenth Japanese surgical congress, are so interesting that it might be well to describe the growth of the transplants in these cases.

I examined changes which took place in every part of the bone. If osteogenesis of transplanted bone were a matter of fact, its growth might be imagined, too; and in this relation all my experiments were with the epiphyseal line in young growing animals.

Since changes of the transplanted bone took place in a short time after the transplantation, as Frangenheim said, I should like to make a preliminary report of the early experiments at this time.

Here I wish to thank Prof. Dr. Sumita for his kindness in suggesting this theme to me and for his help in writing this article. He has shown me a case of transplantation in an animal which might be considered as evidence not only of a surviving transplant but of its growth.

METHOD OF EXPERIMENT

The animals used for these experiments were young dogs, 1 and 2 months old. Under strict asepsis, I freed an entire radius from its surrounding tissue, removed it, and then replanted it into the same dog in an inverted position, or at times exchanged it with a similar bone of another dog, placing it here also in an inverted position. In the operation I avoided trauma to the surrounding tissue. Concerning the periosteum, I conserved it entirely with the transplant, but sometimes before the transplantation I stripped it off entirely with a knife after removing the transplant from the body.

In every case before the operation roentgenograms were taken and repeated after the transplantation at certain intervals to observe changes in the transplanted bone. The experiments were completed in from 11 to 65 days after the transplantation. The transplanted bone, after being removed from the body, was fixed in formalin solution, nitric acid formalin, or Zilken's decalcifying solution; celloidin sections were made and stained with hæmatoxylin-eosin, or with iron-hæmatoxylin.

RECORD OF THE EXPERIMENTS

Experiment 1. Replantation of the left radius with periosteum examined 11 days after the transplantation in a dog, two months old, weight 2,170 grams.

Under general anæsthesia with ether, through an incision over the entire length of the left forepart of the front leg the entire radius was made free and removed. Thereby injury of the periosteum and epiphysis was almost entirely avoided. This bone with its periosteum was replaced in an inverted position. At the time of the operation the radius was 6.5 centimeters long. After the operation a mild suppuration took place in a part of the wound.

Examination 11 days after the replantation. Macroscopical appearance of the transplant: The entire upper epiphysis (in the transplanted position) and the upper part of the diaphysis at the lateral surface were grown fast to the surrounding tissue. The upper epiphyseal line (in the transplanted

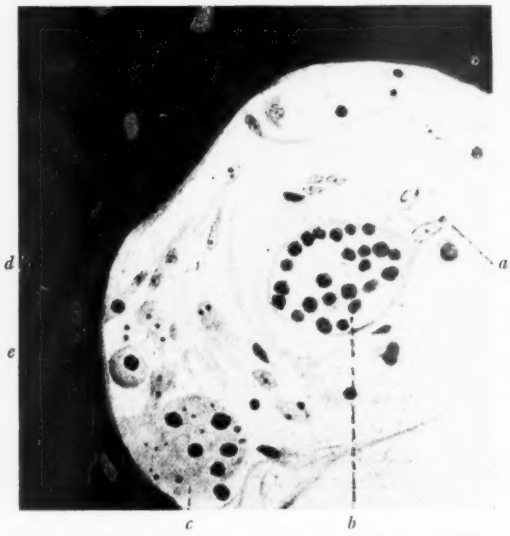


Fig. 1. Experiment 3. A newly built tissue entering into an interlamellar space. *a*, A cell with the form of fibroblast; *b*, a newly built blood-vessel; *c*, a giant cell; *d*, the pre-existing bone substance; *e*, a cell with the form of a polyblast.

Fig. 2. Experiment 3. Entering of newly built tissue into the interlameller spaces of the transplant and the new bone building. *a*, The beginning stage of the new building of the lamellae; *b*, the newly built tissue; *c*, the pre-existing bone substance.

position, and in the following, "upper" and "lower" mean the situation in the transplanted position) showed a furrow-like depression. The part of the transplant which did not grow together with its surrounding tissue lost its periosteum entirely and its surface was smooth. A vertical section of the transplant showed a pale whitish color, losing the color common to the marrow. Nowhere macroscopically was found resorption of the bone substance. Both the upper and the lower epiphyseal line possessed normal color.

Microscopical appearance of the transplant: There were no retrogressive changes in the periosteum; the cell nucleus being as well stained as normal. In the subperiosteal layer, there were no retrogressive changes of cells, but instead, new blood-vessels, cells with spindle and star form and polyblasts were seen coming from the periphery into the structure of the transplant. As yet there was no new building of bone tissue. These cells and blood-vessels had entered into the interlamellar spaces, and not into the pre-existing bone tissue. In the depth of the diaphysis, all cells in the interlamellar spaces had lost their ability to take the stain. The bone-cells also stained but slightly. Between the cortex and the central part of the bone there was a zone showing degeneration of the cells. In this latter part all cells had lost their ability to take nuclear stain. The cells of the epiphysis had an appearance of shrinking to a slight degree, but there were no distinct retrogressive changes. The pre-existing cartilage-cells showed no changes suggestive of proliferation. The cells of the epiphyseal line showed no degeneration, but very beautiful direction-phenomena. Nowhere was there seen an increase of giant cells, nor a resorption of bone tissue.

EXPERIMENT 2. Replantation of the right radius, without periosteum, examined 12 days after the transplantation, in a dog three months old, weight 2,110 grams.

Under general narcosis by ether inhalation preceded by a morphine hypodermic injection, through an incision similar to that in the former case the right radius was removed, and after stripping off the entire periosteum this bone was replaced in an inverted position. At the time the operation was performed the length of the radius was 7.7 centimeters. The wound healed by primary union, and 2 or 3 days after the operation the animal used its leg but walked in a limping way.

Examination 12 days after the transplantation. Macroscopical appearance of the transplant: The vertical section of the transplant showed a pale, whitish color but the color of the epiphyseal line was normal. Nowhere on the surface of the transplant could be found areas of resorption. Between the joint surface of the upper end of the radius and the lower end of the humerus were to be found no extraneous tissues.

Microscopical appearance of the transplant: The subperiosteal layer consisted of connective tissue rich in cells. In the cambium layer (the most super-

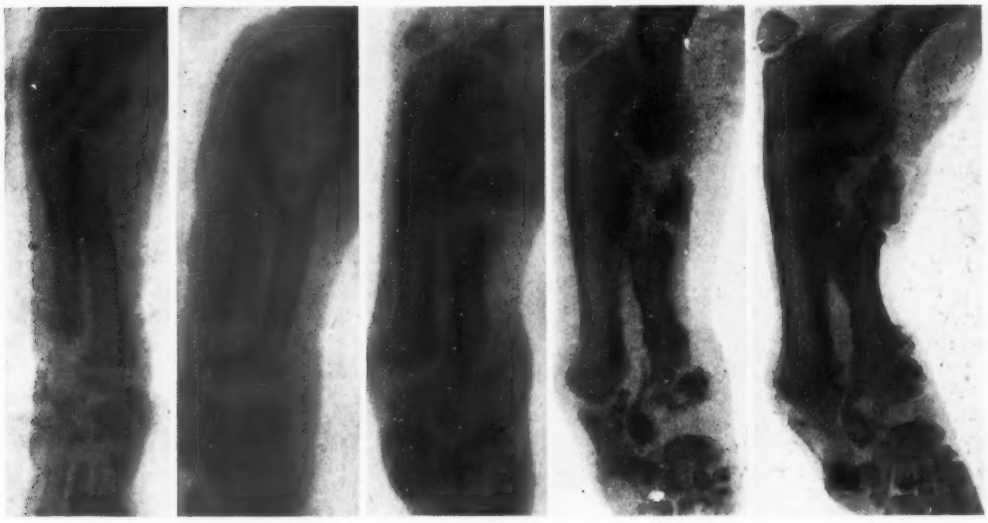


Fig. 3. Fig. 4. Fig. 5. Fig. 6. Fig. 7.

Fig. 3. Experiment 6. Before the transplantation.
Fig. 4. The end of the second week after the transplantation.
Fig. 5. The end of the fourth week after the transplantation.
Fig. 6. The end of the sixth week after transplantation. The upper and lower epiphyseal lines are not changed.
Fig. 7. The end of the eighth week after transplantation.

ficial layer of the corticalis) there were found many cells but no degeneration. Cells in the epiphysis showed no degeneration and in various places, very clearly stained cells were arranged in groups suggesting cell-proliferation. Most of the bone substance of the ossifying nucleolus in the middle of the epiphysis remained, but the majority of the bone-cells lost their nuclear staining power. In this region cells were seen entering into deep tissues from the periphery. These cells consisted of two forms: the polyblasts and the spindle or star-shaped cells. The cortex had many new vessels entering from the periphery and was rich in cells. Here spindle and star-form cells built a coarse network in which were found many polyblasts. The deeper the layer, the greater the diminution of the number of cells, and in the deeper layers erythrocytes were mixed with other cells with nuclei that have been extravasated in the mass of detritus. In the deepest parts were found neither cells with nucleus nor erythrocytes. In the interlamellar spaces, spindle or star-form cells formed the basis of new tissue. In some places were found many enlarged polyblasts. No spindle-form cells that had entered into the bone substance could be found. Most of polyblasts lay near the pre-existing bone, and a few of them had entered it. As yet no sign of ossification could be found. The cells of the epiphyseal line showed a very beautiful direction phenomenon but no degeneration.

In the diaphysis, the blood-vessels and connective tissue had entered into the interlamellar spaces of the superficial layer. In the enlarged interlamellar spaces giant cells were to be found. But as yet no new building of the bone-tissue was seen. Most of the original cells had changed their ability to take stain, but in the superficial layers many cells were found that showed no such changes. In the depth of the marrow, the marrow-cells and blood-vessels lost their nuclear stain, and in this part we could find neither new blood-vessels nor new tissue. Near the lower epiphyseal line no new cells had entered. Most of the cells of the lower epiphyseal line had disappeared, but very few of them remained. However, these cells showed no changes. At the border of the lower epiphysis no changes were to be found, although most of the cells in the central ossified part were degenerated, and some of them were necrotic.

EXPERIMENT 3. Replantation of the right radius, with periosteum, examined 14 days after the transplantation, in a dog two months old, weight 2,597 grams.

Using the same method as in the former case the whole right radius was replanted in an inverted position. The periosteum was kept intact. At the time of the operation the length of the radius was 7.7 centimeters. A few days after the operation the animal walked, using the leg operated on. The wound healed primarily. Extension in the

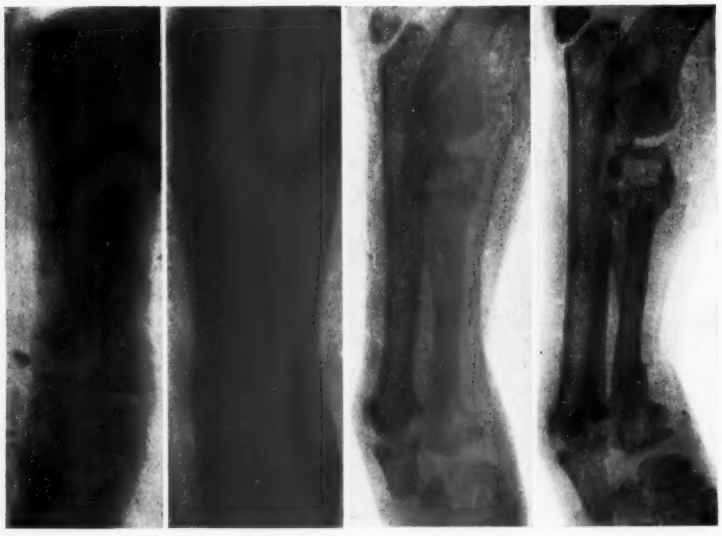


Fig. 8. Fig. 9. Fig. 10. Fig. 11.

Fig. 8. Experiment 7. Before the transplantation.

Fig. 9. The end of the fourth week after transplantation. Ossification has progressed in a relatively large region of the lower end of the diaphysis.

Fig. 10. The end of the sixth week after transplantation.

Fig. 11. The middle of the ninth week after the transplantation.

cubital joint on the side operated on was normal, and the dog could bend the leg operated on in this joint to a right angle.

Examination 14 days after the transplantation. Macroscopical appearance of the transplant: A vertical section of the whole bone showed a pale whitish color, not the color of normal marrow. The color of the epiphyseal line was normal. Nowhere macroscopically could loss of bone-tissue be found. Beneath the joint surface of the upper end of the transplant was found growing bone.

Microscopical appearance of the transplant: The periosteal and subperiosteal layers showed no degeneration, and they were rich in cells. In the middle of the diaphysis was found new bone tissue which was growing from the periphery into the substance of the transplant. The newly built bone tissue was stained brightly. The staining of the pre-existing bone was less intense. In the new bone the lamellæ were smaller and formed a very beautiful network. In the network, between the lamellæ, we found new blood-vessels which were bridged by scanty connective tissue. As yet, there was seen no growth of marrow-cells (Fig. 1). In the pre-existing bone-tissue which remains in periosteally new built bone, the entire bone-cells have lost the marrow stain. The blood-vessels and cells from adjacent layers had entered into most of the interlamellar spaces of the pre-existing bone. Three kinds of these cells were distinguishable: (1) a spindle or star-form; (2) different forms showing from small round to polygonal small or large (the former are supporting cells and are indistinguishable in their morphology from the common fibroblasts; the latter are phagocytes and are indistinguishable from the polyblasts); (3) giant cells which resemble a group of polyblasts. The cells of the polyblast form and others with the form of fibroblasts appear at the same time in the interlamellar spaces. Perhaps the cells of the fibroblast form built the new tissue, while the polyblasts destroyed and resorbed the pre-existing bone-tissue. If this process is advanced, the interlamellar spaces enlarge by gradual disappearance of the old bone lamellæ and are occupied with new connective tissue. At this time a tissue rich in cells appears which centers about blood-vessels. This tissue builds a network by its connection and changes into the normal character of bone-lamallæ, following the appearance of small bone bodies and cells therein with an increasing ability to stain (Fig. 1).

The first cells which make connective tissue around the blood-vessels and the cells which grow into the bone-lamellæ have the same form so that no morphological difference can be found between them. Nearing the epiphysis, the new building of bone decreases more and more, and almost all of the marrow-cells and bone-cells have lost the staining power of their nuclei. The cells of the epiphyseal line show no retrogressive changes, but

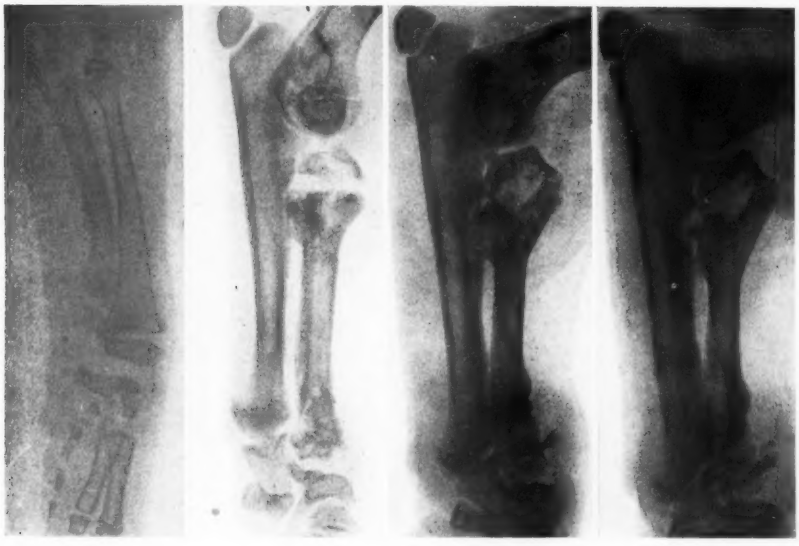


Fig. 12. Fig. 13. Fig. 14. Fig. 15.

Fig. 12. Experiment 8. Before the transplantation.

Fig. 13. The end of the fourth week after the transplantation. A slight depression is seen in the ulna opposite the upper end of the transplant.

Fig. 14. The end of the sixth week after the transplantation.

Fig. 15. The beginning of the ninth week after the transplantation.

in the ossification center the marrow-cells have entirely lost the staining power of their nuclei.

EXPERIMENT 4. Transplantation of the right radius (homotransplantation), with periosteum, examined 19 days after the transplantation in a dog two months old.

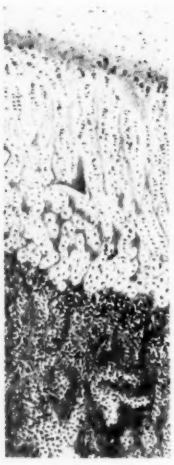
By the same operative method as in the former cases the right radius of one young dog was exchanged with a similar bone of another young dog, and transplanted in an inverted position with the periosteum intact. At the time of the operation the length of radius was 6.5 centimeters. A few days after the operation the dog used the leg operated on but walked with a limp. The operative wound healed primarily, but the wrist-joint became flail-like.

Examination 19 days after operation. Macroscopical appearance of the transplant: The vertical section of the transplant appeared pale and whitish, and showed no places having color of the normal marrow. The epiphysis had normal color and we found no resorbed places on the surface of the transplant. Between the upper end of the transplant and the joint surface of the lower end of the humerus, there was no union.

Microscopical appearance of the transplant: No degenerative changes of the periosteum were present. In the subperiosteal layer, the cells in some parts were degenerated but in other parts were well conserved. These parts usually are rich in cells. Most of the marrow-cells show a tendency toward degeneration and occasional weakly staining bone-cells remain. Near the epiphyseal line in the diaphysis, cells which had entered into the transplant were very scanty and they were found in groups only in the periosteal layer. Cells were progressing from this part into the deeper layers of the transplant. In the middle of the diaphysis, blood-vessels and accompanying cells had entered from the surface into the deeper layers of the transplant. Occasional giant cells were found. In some parts new bone-tissue had formed in the cortex, the latter showing new bone-lamallæ. Yet, in the newly formed interlamellar spaces the proper marrow-cells had not appeared. In this part we did not find cells entering into the marrow. Cells of the cartilage of the epiphysis show no degeneration. In the central ossified parts, most of the cells were degenerated but a few of the cells conserved their nuclei weakly stained.

EXPERIMENT 5. Homotransplantation of the left radius, with periosteum, examined 20 days after the transplantation, in a dog two months old, weight 1,216 grams.

By the same operative method as in the former cases, the whole left radius of a young dog was exchanged with a corresponding one of another dog of the same litter, and transplanted with the perios-



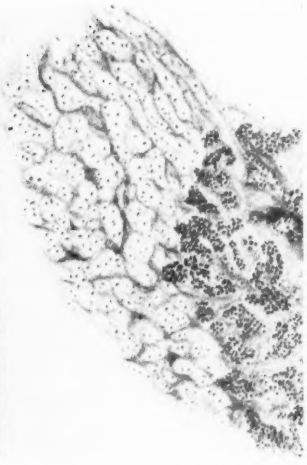


Fig. 16 (at left). Experiment 8. The upper epiphyseal line not changed. (65 days after the transplantation.)

Fig. 17. The epiphyseal line, in which the arrangement cartilage cells has become irregular. In parts in spite of poliferation the direction phenomenon is lost.

teum, in an inverted position. The dog, a few days after the operation, used the leg but walked with a limp. The wound healed primarily.

Examination 20 days after transplantation. Macroscopical appearance of the transplant: The transplant had grown to its surrounding tissue very well and a vertical section showed a thinning of the epiphyseal line. Otherwise we can find nothing abnormal except the pale whitish color of the marrow.

Microscopical appearance of the transplant: The periosteum showed no degenerative change but was rich in cells. All the cells in the interlamellar spaces and the bone-cells had lost the staining power of their nuclei. In the subperiosteal layer new blood-vessels had arisen and from this part there was growing new tissue into the deeper layers of the transplant. The cells of the epiphyseal line were entirely degenerated. From a part of the epiphysis, connective tisse was entering into the cartilage tissue. All the cartilage-cells conserved the stain of their nuclei but were shrunken.

EXPERIMENT 6. Replantation of the right radius, with periosteum, examined 42 days after the transplantation, in a dog two months old, weight 2,620 grams.

By the same operative method as in the former cases, the right radius was removed from the body and replanted in an inverted position with the entirely conserved periosteum. From the next day after the operation the dog used the leg operated on but walked with a limp. Healing of the operative wound was by first intention. At the time of the operation, the length of the radius was 5.4 centimeters. At the time of the death of the animal, the forepart of the front leg was of just the same size as that of the other side but its length was 2 centimeters less than that of the opposite side. Both flexion and extension of the cubital joint were normal but rotation of the foreleg was impossible. This was fixed in a mid position. As the wrist-joint was wobbling, the dog could not keep it in an extended position in walking but bent it to a right angle, touching the floor with entire part below this joint. This dog limped till death. At death this dog weighed 8,200 grams.

Examination by X-ray, end of the second week: The contour of the transplanted bone was even and did not show any diminution of the bone shadow. Both the length and thickness of the transplant were the same as when it was transplanted (Fig. 4).

End of the fourth week: The shadow of the bone was diminished in the upper and lower end of the diaphysis of the transplant, being especially clear at the lower end, so that the lower end seemed as if it had been divided into several parts (compare with the microscopical view). Also the contour of the upper end had become irregular. While the contour of the upper epiphysis had become irregular, its thickness was increased. No remarkable changes were present in the lower epiphysis (Fig. 5).

End of the sixth week: The changes of the upper end of the diaphysis seemed greater than in the fourth week; yet, in the lower end we found no more diminution of the bone shadows and the lower epiphysis which had been divided in several parts by the disappearance of bone shadows, had remarkably enlarged. The middle part of the diaphysis showed an even contour and an increase of its thickness but no disappearance of the bone shadow. The upper epiphysis appeared as if it were divided into several parts by the disappearance of bone shadows but every piece was enlarged. The lower epiphysis also showed a view of slight disappearance of substance in the middle of its surface. The upper and lower epiphyseal lines were not changed (Fig. 6).

End of the eighth week: The diaphysis not only showed diminution of the bone shadow but a remarkable increase in its thickness; also the divided pieces of the bone in the lower part were enlarged, so that between them and the diaphysis remained a septum like a line. The upper epiphysis was enlarged, too, but the middle part, which had remarkable transparency, remained as in the former examination. Also the lower epiphysis had no appearance of resorption of the bone substance but it was remarkably enlarged (Fig. 7).

Macroscopical appearance of the transplant: The upper and lower epiphysis and the diaphysis are well distinguished from each other by the epiphyseal line; the cartilage of the epiphysis and epiphyseal line showed no changes except a slight irregularity of the cartilage of the joint surface. And the marrow possessed a normal color (at the section of

the transplant within 20 days it has showed a pale whitish color). At the transplant, the surface toward the skin was smooth, but that toward the ulna had an area at which a tissue like connective tissue had entered into the transplant. The cavity of the cubital joint, on the radial side, was nearly filled with a connective tissue. The above-described tissue entered into the transplant and was a part of this tissue. The surface opposite the interosseal line was also slightly uneven. The vertical section of the upper epiphysis was divided, at the lower thirds, into lower and upper part by a tissue which had the appearance of cartilage.

Microscopical appearance of a whole vertical section of the transplant. The upper epiphysis: The greater part of the upper epiphysis consisted of tissue already ossified, and the central part of the upper end was occupied with a connective and cartilage tissue. These two tissues were just beginning to ossify. At the junction of the ossified zone we found two kinds of tissues; the normal connective tissue and the cartilage tissue, and we could make out a part of the ossification of the cartilage and of the connective tissue in the same field. Also, there is a curved strip of cartilage entering from one side of the epiphysis. Nowhere in this cartilage was found tissue showing the normal construction of the epiphyseal line. In the subperichondral layer we found a completely ossified part and another one just ossifying. In the marrow substance of the ossified part, the cells lying in the interlamellar spaces had a normal appearance. All this cartilage tissue above described corresponds to the thin shadow in the X-ray photograph. (This part showed a disappearance of the bone substance, but perhaps it was true that this thin shadow might be interpreted as an irregular proliferation of the cartilage tissue.) The condition of the ossification gives us the idea that this cartilage tissue would soon have ossified and united. The increasing of bone shadow in the X-ray examination perhaps demonstrates this fact.

Diaphysis. There is a small part of the cartilage which had not quite ossified. The cells in the interlamellar spaces and the bone-cells were normal, except it was rich in the interlamellar substance and in consequence the interlamellar spaces are smaller than those of the normal.

The lower epiphysis. We find a curved line-like zone in a part which corresponds to the location of the common epiphyseal line. The ossified part below this zone is hardly as wide as one-third the entire lower epiphysis. Another large part consisted of rapidly ossifying cartilage. At some places in the zone of ossification, we found a view like the direction phenomena of the normal epiphyseal line. As it neared the outward side, this cartilage tissue became a connective tissue; at the periphery it extended into fibrous membrane, and between them we could find no difference in appearance.

To sum up, in this case, the transplanted bone has grown in very well. In the X-ray examination, at the end of the fourth week we found in the lower end of the diaphysis indications of bone resorption, but the microscopical examination showed instead that there had been an irregular proliferation of the cartilage tissue which had ossified within a few weeks. The whole transplant had increased in thickness but not in length.

The microscopical examination showed two tissues, irregularly mixed, one ossified and the other undergoing ossification. The upper and lower epiphyseal lines could be found by both the macroscopical and the X-ray examination, but the microscopical examination revealed an absence of a normal epiphyseal line structure.

EXPERIMENT 7. Replantation of the right radius, with periosteum, examined 60 days after the transplantation, in a dog two months old, weight 2,700 grams.

By the same operative method as in the former cases the right radius was removed from the body and replaced, with its periosteum, in an inverted position. A few days after the operation the dog used the leg operated on but walked with a limp. The wound healed by primary union. At the time of the operation, the length of the radius was 7 centimeters. Before the death of this animal, the forepart of the front leg was the same thickness but was shorter than that of the opposite side by 2.5 centimeters. Both flexion and extension of the cubital joint were normal, but rotation of the foreleg was impossible. In walking, the dog touched the floor with the entire part below the wrist-joint of the side operated on, flexing this joint to a right angle. This animal limped till its death but walked very actively, using the leg operated upon.

X-ray examination, end of the fourth week: The greater part of the diaphysis shows no changes but the contour of the upper and lower end has become irregular. In the central part of the upper epiphysis, the penetration of the X-ray is diffusely increased. The upper epiphyseal line showed distinctly but the lower epiphyseal line did not. Ossification had progressed (Fig. 9) in a relatively large region of the lower end of the diaphysis.

End of the sixth week: In the lower end of the diaphysis the proliferation of the bone substance had progressed well but otherwise the diaphysis showed neither changes nor an increase in length. The penertation of the X-ray through the central part of the upper epiphysis had increased very remarkably. The lower epiphysis showed an enlargement. The upper epiphyseal line was distinct, but the lower epiphyseal line was not. The surface of the ulna was dense where it touched the upper end of the transplant (Fig. 10).

End of the ninth week: No remarkable changes were present in the diaphysis. The penetration of the X-ray in the central part of the upper end of the diaphysis had increased more and more, but the whole diaphysis had enlarged. The upper epiphyseal line was distinct but the lower epiphyseal line

was not. The transplant shows no increase in length. The ulnar shadow has increased (Fig. 11).

Death of the experimental animal occurred 60 days after the transplantation; the weight at this time being 7,760 grams.

Macroscopical appearance of the transplant: The transplanted bone had grown in very well. Its surface was smooth and on vertical section its entire appearance was normal, so that every component of the bone could be distinguished. Thus the periosteum, cortex, marrow substance, etc., conserved their characteristics. The surface of the upper epiphysis had become irregular. The upper epiphyseal line was thinnest at its center, increasing in thickness peripherally. Otherwise, it had the appearance of a normal epiphyseal line. The lower epiphysis could not be distinguished as the epiphyseal line had become indistinct. By the replantation in an inverted position the large end replaced the small upper end of the radius. This produced a gap between the lower end of the transplant and the carpal bones. However, this was occupied by the newly formed cartilage which had ossified in areas. The length of the transplant had not increased. The increase in thickness was confined to the lower end of the transplant. This area showed a remarkable proliferation of the cartilage cells and ossification.

Microscopical appearance of the transplant: The greater part of the center of the upper epiphysis consisted of living marrow substance but scattered therein were cells which did not take the nuclear stain. The periphery and the side opposite the epiphyseal line consisted of cartilage but the upper surface became connective tissue. In the cartilage, no necrotic areas were seen. The surface is covered with fibrous tissue. The entire diaphysis consists of living bone tissue. But the bone-lamellæ are thick and dense; and, in consequence, the interlamellar spaces are small and contain few cells. The lower epiphysis consisted of ossified tissue and cartilage; these two tissues were intermixed. The ossification took place in the cartilage and connective tissue. The contents of the interlamellar spaces were just the same as that in the normal bone. Nowhere was dead tissue found. The lower epiphysis was covered by a relatively thick connective tissue. While the upper epiphyseal line remains a living zone of the cartilage, it has lost the usual structure which was altered by very irregular arrangement of the cartilage cells. While we could not discern the lower epiphyseal line, either by the X-ray or by macroscopical examination, the microscopical section showed the characteristics of the epiphyseal line to be preserved. In this region, cartilage and bone cells lay close to each other; there was no boundary line, which Sumita maintained was an indication of the cessation of growth of enchondral bone. This suggests that this part may grow in length. The larger part of the epiphyseal line has lost its characteristic structure and is replaced by fibrous tissue.

To sum up this case, the operative wound healed primarily, and the transplanted bone grew in very well. While the growth in length of the forepart of the front leg on the side operated on had ceased, the thickness of this leg increased. In spite of the excessive motion in the wrist-joint and the limitation of the rotation of the forepart of the leg on the side operated on, the animal used this leg very actively. The X-ray examination indicated that some parts of the bone substance had disappeared, but these areas were occupied by irregularly proliferated cartilage. In the diaphysis no bony defects were found. There was a remarkable proliferation of cartilage and its ossification to fill the defect at the distal end, resulting from the inversion of the radius, which replaced the large end of this bone with the small end. Vertical section of the transplant presented the normal long bone characteristics. In the central part of the upper epiphysis, we found that a small number of the bone-cells had lost their nuclear stain. Elsewhere the transplant, microscopically, consisted of living bone and cartilage.

EXPERIMENT 8. Replantation of the right radius, without periosteum, examined 65 days after transplantation, in a dog two months old, weight 2,850 grams.

By the same operative method as in the former cases, the right radius was removed and then transplanted in an inverted position after stripping off the entire periosteum. The length of the transplant at the time of the operation was 7.2 centimeters. The operative wound healed primarily. At the death of the animal, the forepart of the front leg on the side operated on was shorter by two centimeters but was of the same thickness as its fellow of the opposite side. The flexion and extension of the right cubital joint was normal but the rotation of the forepart of this leg was impossible. The wrist-joint, when the dog walked limpingly, had been bent to a right angle, touching the ground with the entire part below this joint. But the animal had used this leg very actively. Death of the animal 65 days after transplantation. The last weight was 9,430 grams.

Examination by the X-ray: The contour of the upper and lower end of the diaphysis is irregular, but the greater part of its middle is smooth, and the entire diaphysis has increased in width, with the enlargement marked, especially in the lower end. In the middle part of the upper epiphysis, the penetration of the X-ray has increased very remarkably so that the upper epiphysis is divided into two regions. The transplant has increased in length very slightly. The lower epiphysis showed no great changes and its enlargement is not so marked. The ulna showed a slight depression opposite the upper end of the transplant (Fig. 13).

End of the sixth week: The middle and lower end of the diaphysis showed no changes but in the upper end there was a semilunar area with an increased penetration of the X-ray. The diaphysis had

increased somewhat in thickness. At the upper epiphysis the areas, which formerly seemed divided, had united, leaving a central perforation. The entire upper epiphysis had enlarged. The lower epiphysis was greatly enlarged. The upper and lower epiphyseal lines, both of which had spread, have again become narrow. A proliferation of the bone substance in the tissue surrounding the lower epiphyseal line was seen. The depth of the ulna has increased, thereby forming a new hollow for a joint (Fig. 14).

Beginning of the ninth week: No remarkable changes at the upper and the middle part of the diaphysis were seen. Its lower end has enlarged a little. The area which had seemed as if perforated has become smaller by the progression of the ossification. The proliferation of the bone tissue has progressed markedly (Fig. 15).

Macroscopical appearance of the transplant: The transplanted bone has grown in very well. Its surface is smooth throughout. On vertical section it appears normal, so that every component can be distinguished; the periosteum, cortex, marrow substance, etc., conserved their characteristics. In the middle of the upper epiphysis the bone substance has disappeared and has been replaced by connective tissue. The lower end of the transplant showed a remarkable growth of connective tissue and occupied a great defect between the lower end of the transplant and the carpal bones, produced by the replantation in an inverted position.

Microscopical appearance of the transplant: I made microscopical preparations from the whole vertical section of the transplant. The upper epiphysis showed a very irregular surface, and the ossified areas were divided by cartilage-like septa. We found a tissue resembling connective tissue entering at the middle of the surface. The upper epiphysis was covered with a relatively thick connective tissue, and parts of it, lying directly under this cover, had been ossified to a great extent, while other areas consisted of cartilage. In the ossified areas, the cells in the interlamellar spaces were not dead as were those in the marrow of the ordinary bone. At the surface of the transplant in the diaphysis we found periosteum which developed as well as the normal periosteum. At the upper and lower epiphysis and in the cortex a living bone remained; but the cells in the marrow had lost their staining power. There were bone-cells, the nuclei of which stained weakly but by closer observation we noted that in most of them the cell bodies were shrunken, and had lost their nuclear characteristics.

In the interlamellar spaces bone-cells were found, while deeper, here and there, giant cells were present. Nowhere in the pre-existing bone was there development of cartilage. The greater part of the tissue developed in the region of the lower epiphyseal line consisted of cartilage and but a small part of that ossified. In the ossified part, the normal marrow-cells developed. Dead tissue is nowhere to be found. A trace only of the upper epiphyseal line remained. This was no more than a small area in the center of the upper end of this diaphysis that remained as real cartilage. This is very curved and its breadth varies greatly in its different parts. A tissue conserving the normal construction of the epiphyseal line was found (Fig. 16). In this region there was no boundary zone; the cartilage-cells lay close to the marrow-cells. At one portion of the diaphysis near this area, ossification had progressed. In spite of the active proliferation in parts of the epiphyseal line, the direction phenomenon was lost, and the arrangement of cells became very irregular (Fig. 17). As above described, cartilage tissue in great quantity has enveloped the region of the lower epiphysis; but the original epiphyseal line is lost, as no tissues conserving the construction of the epiphyseal line remained.

To sum up in this case, the transplanted bone had grown in very well. An increase in the length of the forepart of the front leg on the side operated on had taken place, though this growth had been obstructed. This part of the foreleg had enlarged as well as its fellow of the opposite side. The rotation power of the forepart of the leg was lost and the fixation of the cubital joint was impossible, yet the animal used this leg very well. At first under the X-ray examination we found an increase of penetration of the X-ray in the small part of the upper epiphysis and in the upper and lower ends of the diaphysis, but after the fourth week an enlargement of the transplant began, especially at the site of the defect between the lower end of the transplant and the carpal bones. Here we found a new formation of ossifying cartilage in great quantity.

The microscopical examination shows that the transplant consisted of living cartilage and bone, except that the marrow presented changes in the staining power of the nucleoli in the middle part of the diaphysis. The cells of the upper and lower epiphyseal line were proliferated, though most of them lost their characteristics. There is a portion of the epiphyseal line which conserved its characteristic histological construction.

All my experiments were with young growing dogs only. There was neither "heterotransplantation" nor "transplantation of dead bones"; therefore my experiments do not involve the entire question concerning bone transplantation, and are only a part of the transplantation problem. However, I believe that I could have secured experimental material for the investigation of the changes occurring between the period of transplantation and the complete regeneration of the bone. The question arises as to whether the above-described transplants would have degenerated and how they would compare with transplants treated by other operative methods.

Whether transplanted bone can be substituted after it has once lost its ability to live, experiments performed heretofore point out that some areas of the transplant die after the transplantation while others, for example the periosteum, live.

And no doubt the results of my experiments, above described, show that the periosteum can live, as it has shown not only the living appearance throughout every period after the transplantation but also a proliferation of the bone. The epiphyseal line and the epiphyseal cartilage also have shown life after transplantation, and it is here that we find proliferation; although this proliferation was irregular and only slightly active, we were able to confirm a definite, though slight, increase in the length of the transplant. In every case ossification occurred especially in the epiphyses.

In respect to the other living elements, i.e. the bone-cells and marrow-cells, we can affirm that most of the bone-cells lost their nuclear stain within 65 days after the transplantation in the experiment extending over the longest period. This staining power was either entirely lost or conserved to a weak degree.

The marrow-cells lost their nuclear stain in all of my experiments. But I should like to call attention to the fact that the bone-cells and the marrow-cells of the transplant in my experiments are in a most unfavorable condition to get their nourishment, because I transplanted the bone with a completely closed medulla as contrasted to the open method which authors have advocated as being necessary for bone transplantation.

No doubt my experiments cannot be final for the fate of all transplants, many of which are treated in other ways than those in my method.

The bone-cells and marrow-cells, as they have been described clearly in the experiment, reduce their nuclear stain or disappear but they are soon replaced by another component with a stronger living power; therefore, the transplant, on the whole, can live and does not undergo remarkable changes in its form. For this reason I cannot agree with the extreme opinion that all transplants cannot live.

As a result of my experiment I will discuss the changes in every component of the bone after the transplantation, as follows:

The periosteum. Authors are agreed that periosteum transplanted with the bone does not die and has an important bearing in the new bone building; even Barth, who had advocated that the periosteum transplanted with bone dies and that regeneration takes place from the neighboring periosteum, revoked his former view and confirmed the living and producing ability of the periosteum.

But Barchizew and Peterow (5) said, "The transplanted bone, without periosteum, can regenerate completely." According to the opinion of Mayer and Wehner, in spite of the macroscopically complete stripping of the periosteum, the osteoblasts of the cambium layer can be transplanted. In many experiments there are two (the second and eighth) in which the entire periosteum was completely stripped macroscopically; in all other cases the bone was transplanted with its complete periosteum. At no period of our experiments has the periosteum, transplanted with the bone, showed any marked degeneration, and on the whole, was very well preserved. Moreover we found an increase of cells in this layer and we found that these cells enter into the deeper layer of the transplant. In the subperiosteal layer, i.e. the most outside layer of the cortex cells have been usually very well preserved.

In the second experiment, on the transplant without periosteum taken out in 12 days, the layer where the periosteum had been consisted of connective tissue rich in cells in the subperiosteal layer. There was no cell degeneration. As the first step in the new bone building process progressed from the periphery into depths, there were blood-vessels and cells entering the interlamellar spaces. In the eighth experiment, the transplant taken out 65 days after transplantation without periosteum, the proper periosteal layer had increased in areas to a complete periosteum, which had a tendency to unite and to cover the bone. In this case the outer layer of the transplant is replaced by new tissue, while in the medulla the marrow had necrosed. But in the cases of the two dogs of the same litter, in which transplantation

was done with the periosteum intact, the transplants after 42 and 60 days had no dead tissue and, further, the microscopical examination shows active regeneration. In the aperiosteal transplant of the eighth experiment, removed 65 days after transplantation, the growth and regeneration of the bone is slight and we find a moderately large part in the middle part of the diaphysis poorly nourished. On the basis of my experiments I can establish the incontestable fact that periosteum transplanted with the bone can live a long time and actively form new bone. In my opinion the fact that transplanted bone without its periosteum can regenerate, may be due to the cells of the cambium layer, as Mayer and Wehner formerly advocated, for (1) the cells in the subperiosteal layer in all my preparations have been well preserved, and (2) the proliferation of the periosteum in the bed of the transplantation raises no question about the source of regeneration, because I took out the radius with its entire periosteum, and replanted it after having stripped it outside of the body.

For comparison between transplants with their periosteum and those without it, my experiments are not quite extensive enough to establish which method is the better. But I may be allowed to say that the regeneration of the bone, in case of the transplants without periosteum, is delayed and therefore, that the periosteum is very necessary to aid growth and regeneration of the transplant.

The bone-cells and the bone substance. The great majority of authors have held the opinion that the transplanted bone-cells die; but Bonome (7) denied this and insisted that they proliferate. The fact has been shown that the bone-cells can live a long time after the transplantation, for example 90 days (Tomita) and 100 days (Barchizew, Peterow). Mayer and Wehner said:

Die Anschauung, dass der transplantierte Knochen vollstaendig der Necrose verfaellt, muss dahin eingeschraenkt werden, dass wohl die Mehrzahl der Knochenzellen abstirbt, ein Teil sich aber bis zur Vascularisierung des Transplantes erhalten kann. Jedoch geht niemals von diesen Knochenzellen Knochenneubildung aus.

While in my preparations most of the bone-cells had lost their nuclear staining power within certain days after the transplantation, there were cells which retained this for a long time (65 days). But, as a rule, they stained weakly and their nuclei were shrunken, taking on an irregular form. I have never found signs of proliferation of these cells

With respect to the bone substance in the third experiment, I could find Haver's canals gradually enlarged by the entrance of the giant cells and replaced by newly formed tissue, as other authors have noted, yet in the eighth experiment the bone lamellæ remained largely without change in quantity or arrangement.

Marrow. Axhausen and Frangenheim thought that the transplantation of the marrow was justifiable but that conditions must be favorable. In my experiments the marrow-cells have always lost the nuclear staining power. Because I transplanted an entire bone in a completely closed condition, there was no way for nourishment to enter into the medulla; therefore, I have no basis for argument concerning this question. But I can affirm that the marrow-cells which have once lost their staining power can be replaced by some other bone component having powerful regenerative ability.

Joint cartilage and epiphyseal line. Obata's experiment showed that a part of the transplanted joint cartilage, especially that of the periphery, can live while the other parts, especially the central areas, die. The living cartilage has regenerative ability.

In all my experiments the bone-cells and marrow-cells in the central ossified part of the epiphysis have lost their nuclear staining power; but most of the cartilage in the periphery lives and grows. Sometimes after a long period the contour of the epiphysis becomes irregular, and at these irregular areas connective tissue enters. But the proliferation of the cartilage cells, the ossification of the matrix, and an enlargement of the epiphysis always occur.

Experiments concerning the epiphyseal line are increasing year by year, and these, on the whole, confirm the opinion that the epiphyseal line can be transplanted but not without injury to its original character: Helferich (15), Borst, Rehn and Wakabayashi (25), Galeazzi (13), Obata (22), Heller (14),

Erdenlen (18), Axhausen (4), Zoppi (30). As the rule, that part of the transplanted epiphyseal line, lying under the perichondrium, lives, while that in the central areas die.

My experiments show that the epiphyseal line is one of the resistant tissues, like periosteum and joint cartilage, because its cells do not die until 19 days after transplantation. In the seventh experiment after 60 days, a part of the lower epiphyseal line, and in the eighth experiment after 65 days, a part of the upper epiphyseal line had conserved their characteristic construction. There was no indication of the cessation of the echondral bone growth, except the fifth in which after 19 days all cells of the epiphyseal line had died. Besides we find parts with living and proliferating cells but their arrangement has become very irregular, having lost the characteristics of an epiphyseal line. In this period the epiphyseal line does not remain a straight line but shows a remarkable bending.

In spite of the living cells in the epiphyseal line, there is a struggle between three powers. A small part conserves the direction phenomenon and enforces a growth in the long axis of the bone; another part whose characteristic construction has been lost, assumes an irregular arrangement of cells which expand the epiphysis while the connective tissue replacing the dead cells has a tendency to contract. Therefore there is good reason for the failure of growth in the long axis of transplanted bone. My experiment confirms Axhausen's opinion: "Der Epiphysenknorpel ist im histologischen Sinne transplantationsfaehig, doch nur in einem fuer die practische Anwendung unzureichenden Umfange."

From the above experiments the autotransplantation of the half joint will succeed, if there is any indication of growth in the transplant.

Tissues from which transplanted bone regenerates. As sources of bone regeneration those tissues have been mentioned which have a life so resistant that they can protect the new growth of bone. Periosteum, marrow, bone-cells, connective-tissue cells of the bed of the transplant and endosteum and marrow-cells of the recipient have been mentioned. In my experiments, I transplanted in an inverted position an entire radius either with or without its periosteum, after removing it completely from the body. Therefore, I cannot discuss this question, because both the connective tissue in the bed of the transplant and the periosteum and the marrow of the recipient are out of the question as the sources of the bone regeneration. No doubt the fact that in my experiments the periosteum and the subperiosteal tissue do not die but instead increase in number in contrast to the bone-cells and marrow-cells, shows that at least these structures are sources necessary for the protection of the life of the transplant. Besides the epiphyseal line, the epiphyseal cartilage and the perichondrium take part in protecting the life of the transplant. One must take the greatest care not to injure the periosteum and the subperiosteal tissue as they show that they are alive in every period after the transplantation and that there is a formation of bone beneath them which is almost equal to that of the undisturbed normal.

Growth of the transplanted bone. Concerning the growth of the transplanted bone, Ollier said:

L'accroissement en épaisseur se fait teut à fait comme à l'état normal, mais il ne dure pas longtems; les propriétél du périoste, apres avoir été un instant surexcitées, s'arrêtenl définitivement à moins qu'une nouvelle irritation ne vienne les réveiller. Aussi ne faut-il pas compter sur un accroissement des os hétérotropiques comparable à celui des os normaux.

The increase in the thickness of the transplanted bone is distinctly confirmed by the X-ray examination, especially the new growth of cartilage and its ossification that have taken place in those parts exposed to the greatest physiological excitement. This is illustrated by the changes taking place at the defect made between the under end of the transplant and the carpal bones by the inversion of the transplant.

CONCLUSION

1. The bone with its periosteum, if it is transplanted in the same body under favorable conditions, continues to live.

2. While among the various components of the transplanted bone the bone-cells and the marrow have changed their ability to take

the nuclear stain at the end of the third week after the transplantation, the periosteum, the subperiosteal tissue, the epiphyseal cartilage and the epiphyseal line give distinct evidences of life.

3. Among the various components of the transplanted bone the periosteum and the subperiosteal tissue have not only lived throughout every period of the examination but have executed an active formation of new bone.

4. Most of the epiphyseal cartilage and epiphyseal line have lived throughout every examination, as has the periosteum, and they have, moreover, carried on an active proliferation and ossification. Yet they are irregular, losing their physiological relationships.

5. The bone-cells and the marrow have lost or changed the staining power of the nucleus in a short time after the transplantation but the physiological or nearly physiological appearance returns after a certain time, being replaced by the resistant components of the transplants.

6. The aperiosteal transplant grows and regenerates by the proliferation of cells in the subperiosteal layer. But in such a case the new growth of bone is not so active as in the transplants with periosteum. The aperiosteal transplant acquires a new periosteum.

7. The aim of the bone transplantation can be reached without the periosteum and marrow of the recipient. As to the continued life of the transplanted bone, however, I cannot give a definite opinion at this time.

8. Transplanted bone grows; the increase in thickness is marked, although the length increases but little even when transplanted with the epiphyseal line.

BIBLIOGRAPHY

1. AXHAUSEN. Histologische Untersuchungen ueber Knochentransplantation am Menschen. Deutsche Ztschr. f. Chir., 1908, xci.
2. Idem. Die histologischen und klinischen Gesetze der freien Osteoplastik auf Grund von Tierversuchen. Chir., 1909, lxxx. Arch. f. klin. Chir.
3. Idem. Arbeiten aus dem Gebiet der Knochenpath. u. Knochenchir. Arch. f. klin. Chir., 1911, xciv.
4. Idem. Ueber den histologischen Vorgang bei der Transplantation von Gelenkenden, insbesondere ueber die Transplantations faehigkeit von Gelenk- und Epiphysenknorpel. Arch. f. klin. Chir., 1912, xcix.
5. BARCHIRZEW and PETEROW. Beitraege zur Knochenueberpflantzung. Deutsche Ztschr. f. Chir., 1912, cxxxiii.
6. BARTH. Histologische Untersuchungen ueber Knochenimplantation. Beitr. z. path. Anat. u. z. allg. Path., Jena, 1895, xvii.
7. BONOME. Zur Histogenese der Knochenregeneration. Arch. f. path. Anat., etc., Berl., 1885, c.
8. BUCHHOLZ. Einige Versuche ueber kuenstliche Knochenbildung. Arch. f. path. Anat., etc., Berl., 1863, xxv.
9. ENDERLEN. Zur Reimplantation des resecierten Intermediarknorpels beim Kaninchen. Deutsche Ztschr. f. Chir., 1899, li.
10. FRANGENHEIM. Experimentelle und klinische Erfahrungen ueber die Arthrodese durch Knochenbolzung. Arch. f. klin. Chir., 1909, xc.
11. Idem. Ueber freie Knochentransplantation zur Deckung von Defecten langer Roehrenknochen. Beitr. z. klin. Chir., 1909, lxiv.
12. Idem. Dauererfolg der Osteoplastik im Tierversuch. Arch. f. klin. Chir., 1910, xciii.
13. GALEAZZI. Richerche cliniche experimentali sul trapianto della cartilagini interepifisaria. Cited in Hildebrand's Jahresbericht ueber d. Fortschr. d. Chir., 1907.
14. HELLER. Experimentelle Untersuchungen ueber die Transplantation des Intermediarknorpels in Form der halbseitigen Gelenktransplantation. Arch. f. klin. Chir., 1914, civ.
15. HELFERICH. Versuche ueber die Transplantation des Intermediarknorpels wachsender Roehrenknochen. Deutsche Ztschr. f. Chir., 1899, li.
16. LAEWEN. Arch. f. klin. Chir., 1909, xc.
17. LEXER. Freie Knochenplastik, Gelenckversteifung und Gelencktransplantation. Arch. f. klin. Chir., 1908, lxxxvi.
18. Idem. Die Verwendung der freien Knochenplastik nebst Versuchen ueber Gelenkversteifung und Gelenktransplantation. Verhandl. d. Deutsch. Gesellsch. f. Chir., 1908.
19. MARCHAND. Der Process der Wundheilung. Stuttgart: 1901.
20. LOBENHOFFER. Beitraege zu der Lehre von der freien Osteoplastik. Beitr. z. klin. Chir. 1910, lxx.
21. MAYER and WEHNER. Neue Versuche zur Frage der Bedeutung der einzelnen Komponenten des Knochengebes bei der Regeneration und der Transplantation von Knochen. Arch. f. klin. Chir., 1914, ciii.
22. OBATA. Ueber Transplantation von Gelenken bei jungen Tieren, mit besonderer Berucksichtigung des Verhaltens des Intermediarknorpels. Beitr. z. path. Anat. u. z. allg. Path., Jena, 1914, xxxix.
23. OLLIER. Traité éxpérimental et klinique de la régéneration des os. Paris: 1867.
24. POKOTILO. Arch. f. klin. Chir., 1910, xciii.
25. REHN and WAKABAYASHI. Die homoplastische Transplantation des Interemdiarknorpels im Tierexperiment. Arch. f. klin. Chir., 1912, xcvii.
26. SUMITA. Zur Lehre von den sogenannten Freundschen primaeren Thoraxanomalien. Deutsche Ztschr. f. Chir., 1911, cxiii.
27. Idem. Interesting experiments in bone transplantation. Tr. XV Japanese surgical society No. 1, 1914.
28. TOMITA. Deutsche Ztschr. f. Chir., 1907, xc.
29. Idem. Arch. f. path. Anat., etc., Berl., 1908, cxci.
30. Idem. On bone transplantation. Tr. IX Japanese surgical society, 1909, Nos. 2, 3, 4.
31. ZOPPI. Arch. per l sc. med., Torino, 1900, No. 21.

CONGENITAL GENU RECURVATUM

By LIONEL D. PRINCE, M.D., San Francisco
From the Orthopedic Service of the Children's Hospital, Boston, Massachusetts

SYNONYMS: Congenital hyperextension (Sayre). *Luxation du tibia en avant* (Fr). Congenital dislocation of the knee. Congenital anterior subluxation.

Definition: Congenital genu recurvatum is a malformation of the knee present at birth and characterized by a hyperextension of the leg on the thigh, a deformity ranging in degree from a simple exaggeration of the normal extension to a condition represented by subluxation or actual anterior luxation of the tibia on the femur.

Historical: In the group of congenital malformations of the limbs, genu recurvatum is probably the least frequent, yet in recent years it has proved to be a source of much study and controversy. Before the year 1880, the literature contained but few reports relating to this condition. Bard (7), Kleeberg (55), Chatelain (19), Albert (1), Wutzer (122), and a few others had published isolated reports but it was Guéniot (38) who in 1880, first called attention to genu recurvatum in a communication which he read before the *Société de Chirurgie* reporting two cases. The following year, Hibon (45), his pupil, used the cases of Guéniot and of Périer (82) as the subject for his thesis. With the recognition of this condition, many observations began to appear in the literature and even in 1888 Mueller (75) succeeded in collecting 25 cases. Following this article there appeared that of Dechy (27) *Thèse de Lille*, 1890; Phecas (84) *Revue d'orthopedie* 1891, and Spoerri (109) *Thèse de Zurich* in 1891. In 1897 Potel (87) reported 78 collected cases, and in 1900 Drehmann (32) was able to accumulate in the literature and report 127 observations. Since then with the added cases of many observers, among whom may be mentioned Kirmisson (54), Delanglade (28), Derocque (30), Florion (34), Magnus (71), Reiner (91), Rechman (89), Mouchet (74) and Mutel (77), there are at least 165 recorded cases.

RELATIVE FREQUENCY AND SEX

Although a relatively rare deformity, genu recurvatum is the most frequent of the congenital deformities of the knee. As compared with congenital dislocations of the hip, Drehmann in his investigations found the relative frequency to be 5 cases of genu recurvatum to 150 luxations of the hip. The frequency, however, is probably greater than this, as in late years the number of reported cases in the literature has been greatly augmented. Kroenlein (62), one of the early contributors to this subject, cited the relative frequence as 1 case of genu recurvatum to 90 luxations of the hip. The records of the Outpatient Department of the Children's Hospital show the relative frequency as 2 cases of genu recurvatum to 197 cases of congenital hips. As in congenital hips but to a less marked degree, genu recurvatum is more frequent in females, the relation being about 3 to 1 (Potel), while club-foot on the contrary, is more frequent in the male. As to the relative involvement of one or both knees, it may be said that the malformation occurs slightly more frequently as a unilateral than as a bilateral condition. In the 72 cases cited by Potel the frequency was 35 bilateral and 37 unilateral, while in the statistics of Drehmann compiled from 127 cases, the relative occurrence was 49 bilateral and 54 unilateral. If unilateral, the malformation occurs more frequently on the left side.

ACCOMPANYING MALFORMATIONS AND DEFORMITIES

It is not infrequent to have genu recurvatum associated with other congenital anomalies, a combination which occurs so frequently that one might proclaim it to be the rule rather than the exception. The most frequent of these malformations are the talipes which are nearly always double and which may exist, in any of the forms. Potel noted the presence of club-foot 20 times in 78 cases of

genu recurvatum. The co-existence of congenital luxation of the hip is also very frequent and many cases reported in the literature possess this combination. Spoerri (109), Ridlon (94), Drehmann, Cordier (23). Tridon (114), in 120 cases of congenital dislocation of the knee, found the hips dislocated 20 times. The knee itself, in addition to its hyperextension may be in a condition of varum or valgum, the latter condition being more prevalent. (Sayre, 100; Joachimstal, 50; Curtillet and Lombard, 25; Albert, Ridlon.) An internal and external rotation of the leg has also been observed in several cases (Derocque, Drehmann, et al). Other combined congenital anomalies are spina bifida, Kroenlein, Richards (92), Ridlon; hydrocephalus, Delanglade; mongolism, Cordier; cryptorchism, Schoenfeld (102), angiomata, Gusil, cited by Kirmisson; facial paralysis, Beely (9); imperforate anus, Tarnier (110).

Curtillet and Lombard reported a case where in addition to a genu recurvatum there was an anterior luxation of the ulna and radius on the humerus. Hofmokl's (48) case showed a hyperextension of one limb and acute flexion of the other. Permanent flexion of the thighs on the abdomen has been noted in several cases (Delanglade, Florion, Shattock, 104).

SYMPTOMATOLOGY

Genu recurvatum is primarily characterized by a hyperextension of the leg on the thigh, the degree of deformity depending to a great extent on the amount and the flexion of this hyperextension. In the mild cases, the leg thus hyperextended forms with the thigh, an angle of about 170 degrees and flexion although limited, can usually be accomplished considerably past 180 degrees. In the more severe cases, the leg is often hyperextended to form an extremely acute angle with the thigh and although it may be possible to further hyperextend the leg, flexion is either impossible or present to only a slight degree. Any muscular effort on the part of the child tends to further hyperextend the leg, the infant apparently using the flexors of his legs as extensors. In the case reported by Wutzer, the hyperextension was so marked that the anterior surface of the tibia could be brought in contact with the anterior surface of the femur. During active movements of the patient, the toes may strike the face, shoulders, chest, abdomen, or thighs, depending on the degree of hyperextension of the knees. In Hilton's (47) case, the infant usually slept with his toes in his mouth. Examination of the knee itself reveals a most characteristic condition. Though they may be in an abnormal apposition to each other, the adjoining extremities of the tibia and femur are normal in size and contour. There are no evidences of atrophy. Anteriorly may be seen typical cutaneous folds usually 3 or 4 in number due to the condition of hyperextension. These folds are true, articular sulci, such as are seen on flexion surfaces of joints and are not merely superficial cutaneous markings. At birth they are filled with vernix caseosa and in older children with sebaceous material. The skin is abundant on the anterior surface and one may often feel fat pads which make palpation of the head of the tibia or the patella extremely difficult or impossible. One may in some cases feel anteriorly, a prominence of the condyles of the tibia, an observation emphasized by Drehmann as clinical evidence of a luxation. Clinically the patella may be barely palpable or absent. Hartigan (43), Jolicoeur (51), H. L. Taylor (111), Barwell (8). If present, it is usually situated high, being in relation to the anterior surface of the lower end of the femur and apparently taking no part in the articulation. The clinical observations in regard to the patella, however, are wholly unreliable as in some cases where it had been reported absent, its presence was determined later. In the case reported by Jung (52), a patella thought to be absent through negative clinical and X-ray findings, was found at autopsy.

Posteriorly the skin loses its normal redundancy and is stretched, so to speak, over the prominent condyles of the femur. The intercondyloid fossa is readily palpable, and one may feel the pulsation of the popliteal vessels, pressure upon which by reason of the hyperextension has produced cyanosis and œdema in the lower limbs. There is never

any effusion in the knee or evidences of paralysis or atrophies. The joint capsule may be uniformly lax (Wolff, 120; Tarnier), but if present there is usually associated a laxity of other joints. Lateral mobility is rare but was present in the cases of Kroenlein, Myers (78), and that of Curtillet and Lombard. Genu varum or valgum may be an associated deformity with the hyperextension. (Albert; Kroenlein; Meyer; Sayre; Bajardi, 4; Joachimstal). In Sayre's case the leg was abducted 45 degrees on the thigh. There frequently occurs with genu recurvatum, a flexion contraction of the hip as in Delanglade's case, a condition which may tend to inhibit motion at that point. The infant, if left to himself, never flexes the limb but any active movement is expressed in further hyperextension. One may passively increase the hyperextension to a limited degree without causing pain to the patient, but if an attempt is made to flex the knee the child usually cries out and a point is soon reached where further flexion is prevented by a resistance which does not disappear even under anæsthesia. Sudden relaxation of a flexed limb causes it to spring back to its vicious position with an abruptness most striking, the *phènomène du resort* of the French writers. This maneuver is extremely characteristic and apparently is due to the tension of the quadriceps and lateral ligaments.

PATHOLOGICAL ANATOMY

Although the clinical condition of genu recurvatum is well recognized today, the pathological interpretation of the condition is still a subject of great controversy. There are in the literature about twenty autopsies and the pathological finding at some ten operations. Leo Mayer (73), in his comprehensive review of the pathology of this condition, added to the literature a detailed description of an old specimen discovered in the Munich Pathological Institute.

Autopsies have shown very little deformity of the joint, the articular extremities of the femur and tibia are practically always normally developed though slight degrees of atrophy has been observed in some cases. In Delanglade's case, the posterior portions of the femoral condyles were undeveloped to the extent that they formed no projection beyond the posterior plain of the femoral diaphysis. The condylar surfaces are usually parallel, longer and narrower than normal. Differences in the development of the condyles have been noticed in those cases presenting degrees of genu valgum and varum. In occasional cases as in those of Barth (6) and Delanglade, there has been observed an anteverted position of the epiphyseal end of the femur. No actual epiphyseal separation has ever been noted. The patella is often developmentally retarded or atrophied and occasionally absent. In the cases of Hofman and von Salis (98), cited by Mayer, it was completely absent. If present, it usually does not enter into the articulation but is situated above its normal position resting on the anterior surface of the lower end of the femoral shaft from which it may be separated by a bed of fat or cellular tissue (Albert, Delanglade, Jung, Mouchet, Mayer). In Shields (105) case the patella was firmly adherent to the femur. The superior cul-de-sac is often absent. The tibia articulates with the anterior superior portion of the femoral condyles, that is to say, with the portion normally occupied by the patella, and there is usually a faceted depression for its reception. The uncovered posterior part of the articular surface of the femoral condyles may be atrophied (Jung, Magnus) or partially devoid of cartilage (Mouchet). The articulating and non-articulating portions may be separated by a cartilaginous ridge as found in Delanglade's autopsy. The semilunar cartilages are usually normal in size. Cases have been reported where they have been small (Magnus) or partially absent (internal cartilage in Max Reiner's case).

The crucial ligaments are as a rule lengthened and at times atrophied (Barth, Mayer). The capsular ligament is stretched and thickened posteriorly, contracted anteriorly, the latter to such a degree in some cases as to prevent reduction (Shields, Shattock). A condition of apparent capsular atony has been described by some authors (Wolff; Friedleben, 35). The quadriceps muscle in practically all cases, has been found to be

contracted and is largely responsible for the maintenance of the deformity. (Owen, 81; Guerin, 39; Roberts, 95; Mayer.) In Reiner's case, a most unusual laxity of the quadriceps was noted. In several reported autopsies, Tarnier, Delanglade, Mouchet, Magnus, Plagemann (85) and Mayer, a peculiar forward luxation of the biceps was noted the tendon passing in front of the external condyle in such a manner that it become an extensor of the knee, tending in action to exaggerate the deformity (see Fig 1). In Delanglade's case the internal hamstrings were also luxated forward.

Mayer emphasized the importance of the occasional abnormal origin of the gastrocnemius, in the production of the deformity of genu recurvatum. In Jung's case the heads were displaced outwardly, in Mayer's case downwardly, conditions which freed the posterior condyles from the normal forward pressure of the muscle, thus favoring the occurrence of a genu recurvatum.

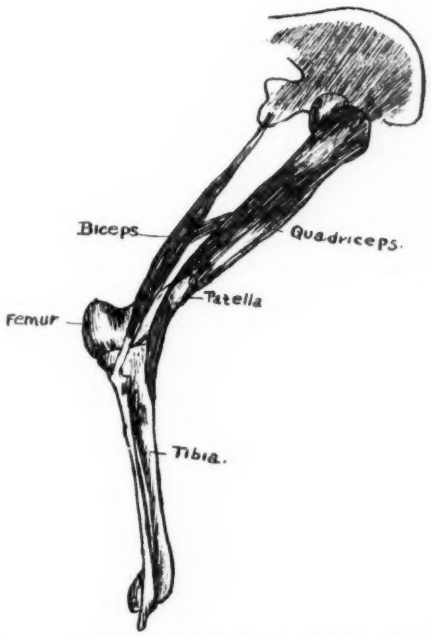


Fig. 1. Dislocation of the biceps forward in congenital dislocation of the knee so that it has become an extensor of the leg. (After Muskat.)

NATURE

With the pathology of genu recurvatum as the basis, many theories as to the true nature of the condition have been suggested. Is the condition of genu recurvatum or congenital hyperextension of the knee primarily due to accommodative contractures and changes at the joint following its retention in a prolonged vicious position, or is it due to an actual anterior subluxation or luxation of the tibia on the femur?

As early as 1880 Lannelongue (66) proposed that the condition of genu recurvatum was a simple hyperextension of the leg on the thigh, without any element of luxation. This view was upheld later by Potel who, after a most careful résumé and study of 78 cases concluded "Genu recurvatum is neither a luxation nor an epiphyseal separation. It is a hyperextension of the leg on the thigh produced by a contracture of the triceps (quadriceps) during fœtal life, the period in which the triceps is involved, varies from the third to the fifth month."

Guéniot, Hibon, Phocas (84), Redard (90), and others maintained and attempted to prove experimentally that the condition of genu recurvatum was due to a femoral epiphyseal separation with subsequent malunion giving rise to the anteversion observed in some cases. But in the reported autopsies and in the careful examination of many radiograms no evidences of any actual diaepiphyseal separation has ever been noted. The occurrence of anteversion of the lower end of the femur in genu recurvatum may certainly contribute to the deformity, but its great infrequency warrants its consideration only as an accessory element in this condition. In one of Delanglade's cases, it was present, while in the other it was absent. In a case reported by Reiner there was, on the contrary, a retroversion of the lower end of the femur. The actual cause of this anteversion may be due to the protracted muscle pull maintained by Potel as the cause of the deformity in genu recurvatum.

Drehmann in 1900, in his comprehensive communication reviewing 127 collected cases including 5 personal observations, was led to

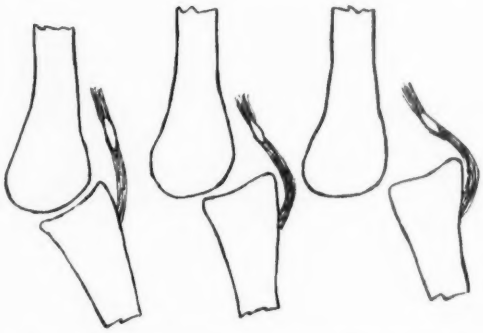


Fig. 2. The development of untreated genu recurvatum into complete dislocation. (After Drehmann.)

conclude that there was no actual difference between genu recurvatum and anterior luxation of the tibia . . . . that the name congenital luxation was much more accurate and that the term genu recurvatum should be reserved for those cases of hyperextension where normal flexion was present and where the femoral condyles were not prominent posteriorly. He classified 106 cases as congenital anterior dislocation. Several cases, he contended were genu recurvatum at birth or in the first months, developing later through weight-bearing, into anterior luxations, a course of development which has its analogy in the development of many cases of congenital hips (see Fig. 2).

Many of the more recent contributors to the literature have confirmed many of Drehmann's views. The autopsies of both Delanglade and Mouchet revealed a definite condition of forward luxation of the tibia. In the cases where operative interference was undertaken, the forward position of the tibia was also noted (Curtillet and Lombard, Reiner, Wolff, Magnus). The great value of the X-ray in determining the presence and the degree of this condition is emphasized by Florion. Kirmisson on the other hand, maintains that the condition of genu recurvatum is not a luxation, but is the "consequence of a vicious attitude prolonged for a great while without true luxation." In luxation, he continues, one sees a partial or total separation of the articular surfaces but one never sees a reciprocal depression on one bone for the reception of the other in its abnormal position. This condition cannot be produced by a sudden displacement as in luxation but can be due only to an abnormal pressure produced by a prolonged vicious attitude, a pressure which results in the anteversion of the lower end of the femur observed in some cases. One may compare, he adds, genu recurvatum to congenital club-foot (equino varus). In this condition there is partial abandoning of the tibia-fibula mortise by the astragalus with distortion of the head and neck of the latter resulting in the loss of its normal relation to the os calcis and scaphoid. There is here as in genu recurvatum an osseous malposition and deformity due to a prolonged vicious attitude. "We do not arrange club-foot in a group of congenital luxations," Kirmisson states, "We do not seek to obtain at a single time a reduction of the deformity or to return at the first onset the articular surfaces to their normal relation." Mutel also emphasized this point in the treatment of a patient whom he cured by progressive corrections. Reduction in luxation, he maintains, is accomplished with a sudden noise or click felt by the fingers and the reduction retains the limb in the corrected position. In genu recurvatum the reduction is usually rapid without pain but will recur immediately if not retained in the corrected position.

To the writer, it seems apparent that many of the contributors in attempting to seek a generic term suitable for the designation of this malformation, have been rather influenced by the case or cases under their actual observation. It has been conclusively demonstrated that this condition shown clinically as a hyperextension of the leg on the thigh, may represent anatomically any degree of deformity ranging from a simple hyperextension without any element of displacement, through all degrees of subluxation to an actual anterior luxation of the tibia on the femur; that a case either may pass progressively from one degree of deformity to the next, or may assume permanently the characteristics of any single degree of this malformation. To attempt to designate the general condition by an expression descriptive of but one type or degree, as for example

anterior subluxation or anterior luxation, is therefore obviously wrong. The term genu recurvatum is the only clinical expression that should be used generically to designate a malformation represented by so many degrees of deformity and the employment of other more specific terms should be used only to qualify or describe the type of genu recurvatum under discussion.

Congenital torticollis, a term which, in its application, may be considered comparable to genu recurvatum, can be a deformity resulting from any one of several anatomical variations. Because of this fact, one is not justified in discarding the expression "torticollis" as a generic term, and substituting in its place a terminology descriptive of its various types.

Leo Mayer suggests and employs the expression "congenital anterior subluxation" as being a more precise term in designating this deformity. He maintains that genu recurvatum is too broad a title and "indicates the symptom not only associated with anterior subluxation but occasionally with posterior congenital sublucation and frequently with other deformities about the knees as in rachitis bowing of the tibia and improperly reduced fractures."

With the exception of the congenital posterior subluxation, the other types suggested are conditions of acquired deformity, all of which should and can be readily differentiated from the congenital form of genu recurvatum.

PATHOGENESIS

The actual intra-uterine and prenatal conditions contributing to the deformity of genu recurvatum are as for other congenital malformations, as yet undetermined. Heredity plays no part in its occurrence, although there are in the literature a few cases where congenital deformities existed in other members of the family. Ridlon reported two sisters, one of whom possessed a bilateral genu recurvatum, the other a bilateral genu recurvatum and a dislocated hip. In Baker's (5) case, the father, the aunt, and two uncles had club-feet, the patient having a double genu recurvatum and club-feet. Magnus reported a family of four children, three of whom had genu recurvatum. Injury or trauma to the mother during the prenatal period, has been attributed as an etiological factor and in some cases, may, no doubt, have an accessory bearing on the condition. In Skelton's (107) case, this trauma was thought to be produced by an unusual habit the mother had of carrying a child two years old astride her pregnant abdomen. Hydramnios, an associated condition that has been observed many times (Blanc, 13; Timmer, 113; Wagner 117; and Chambrelent, 18) has been thought by some writers to be the causative agent. In Chambrelent's case, the amount of fluid was nearly 4 liters. In the majority of cases, normal deliveries with head presentation have been observed, but breech deliveries have been not at all infrequent (Bouvier, 15; Bertin, 10; Kroenlein; Richards). Mueller observed a face presentation. The relative infrequency of all these conditions, however, in cases of genu recurvatum strongly suggests that they were merely coincident and probably had no direct etiological bearing in the production of the deformity. The theory of germinal alteration as has been proposed for club-feet by Bessel Hagen or for congenital luxation by Dollinger and others has been abandoned. Verneuil attributed the condition to a contraction of the extensors of the leg, following a paralysis of the flexors, but this theory is not compatible with the speedy recovery not infrequently observed in these cases. The theory of increased intra-uterine pressure as a cause of the malformation is emphatically denied by Potel who attempts to prove that this pressure if present would have the tendency to reduce the deformity rather than increase it. He attributes the deformity to a primitive contracture of the quadriceps produced by an arrest of development occurring during the third to fifth month as indicated in the atrophy or absence of the patella; a contraction produced by a prolonged muscle spasm of central origin, after the theory of Broadhurst. For the majority of contributors, this quadriceps shortening is due to secondary nutritive and physiological changes in the muscle following the condition of hyperextension. In Delanglade's case the muscle was pale and atrophic.

The theory of Wolff and Strohmeyer that the condition is due to capsular atony, is questionable. Capsular atony, noted in a very few cases, allows flexion of the knee as well as hyperextension and lateral mobility, rare conditions in genu recurvatum. Kirmisson has looked for a single cause to explain many of the associated congenital deformities. The extremities are held in front of the trunk during the normal development of the fœtus and many factors such as intra-uterine or extra-uterine pressure, amniotic bands, oligohydramnios may retain them in an abnormal position. Under the influence of this prolonged vicious attitude the deformities of genu recurvatum, club-feet, and dislocated hips may occur owing to displaced or abnormal epiphyseal cartilage and deferred epiphyseal ossifications.

The most plausible theory is that suggested by Drehmann. At the period of differentiation of joints, the knee is held extended, normal flexion being prevented by the catching of the foot on the chin, in the axilla, shoulder, or some other obstacle. The limb at this period is undergoing rapid growth, the muscles are undeveloped and though there may be an abundance of amniotic fluid, flexion of the knee is impossible, and the condition of hyperextension results. Simple hyperextension may first result and later a subluxation or true luxation. The other associated deformities as club-feet, congenital hips, etc., may occur with this condition. There can be no doubt that many of the infants at birth show an attitude strikingly suggestive of this theory. They are usually born with marked flexion of the thighs on the abdomen, leg hyperextended, a short of jack-knife position. In Wehsarg's (118) case cited by Mayer, an intra-uterine examination just before delivery revealed this position. The actual cause of the retention of the limb in Kuestner's (65) case was a locking of the foot in the axilla. An absence of the chin due to the prolonged pressure of the sole of the foot on the face was observed in Shattock's case, cited by Shields.

DIAGNOSIS

The clinical condition of congenital genu recurvatum is so striking that its diagnosis should offer very little difficulty. Its presence at birth, the co-existence of other congenital deformities, the absence of stigmata of rickets, establishes its congenital nature beyond doubt. One must differentiate luxation deformities if the condition is one of this type, from some forms of arthritis and paralysis of muscles. The congenital anteflexion of the tibia described by Kirmisson and by Jalaguier may produce the genu recurvatum, but there is usually very little difficulty in differentiating the two conditions.

PROGNOSIS

The prognosis of genu recurvatum is good and under a careful and well regulated treatment, the results obtained are usually most gratifying. The prognosis may depend on the early treatment of the patient but not necessarily so. In the case of Hilton mentioned by Potel, the child, 22 months of age, walked on its femoral condyles, "the leg directed forward, the feet in the air, the soles of the feet faced directly upward." In the case of Reiner, the child had a genu recurvatum in which the legs were at right angles to the thighs, the patient, on standing, used the calves of the legs as one normally used the soles of his feet. By grasping his feet in his hands and alternately raising his limbs at the same time swaying his body to the opposite side, the patient was able to walk. Both cases recovered under proper treatment.

Joachimstal reported the spontaneous cure of two cases and advised delay in interference.

TREATMENT

The therapy of genu recurvatum should be governed absolutely by the type, under consideration, and, if one wishes to obtain the best results, the method employed must be chosen only after a most careful clinical and radiological study of the case under observation. That this condition may present any single or several successive stages from a simple hyperextension of the knee without any element of luxation, through the various degrees of subluxation to an actual luxation has been well demonstrated. Expectant treatment although successful in some cases (Joachimstal) is not to be advised for genu recurvatum any more than for club-foot or

congenital dislocation of the hip, and the best results may be promised in those cases where the earliest possible treatment is instituted.

In simple hyperextension and many of the milder forms of subluxation, progressive flexion, manipulation, and massage followed by careful retention of the limbs in the improved position may be all that is necessary for a complete recovery. One must use great caution and govern himself by occasional radiological examinations as it has been shown in some cases that the supposed reduction may be only apparent, while in other cases the corrective movements have actually increased the degree of subluxation.

In more severe types of subluxation and in luxations, a maneuver similar to that employed in traumatic luxations may be used. Under anæsthesia, the limb is held in traction and an exaggeration of the tibial hyperextension maintained at the same time. Backward pressure is then exerted on the tibial head, counter pressure on the femoral condyles and by a rapid movement of flexion, the luxation may be reduced. The hamstring tendons which, when traction is made on the limb, prevent reduction of the tibial head by a "button hole" approximation similar to that observed in a dislocation of the thumb, are relaxed in this maneuver. Care should be taken to prevent complications such as fracture of the femur (Drehmann) or separation of the epiphyses (Shields). Mayer suggests the possibility of using the Bradford congenital hip machine to accomplish reduction in these cases. Following reduction the joint should be held in flexion by plaster of Paris or some other form of splinting, and massage and passive motion regularly instituted.

If reduction by these methods is unsuccessful, open operative interference is indicated. The operations advised for the cure of this malformation consist chiefly in overcoming the obstacles to reduction, either by division or by plastic methods. The quadriceps tendon is probably the most frequent obstacle, though Drehmann maintains that the hindrances to reduction are mostly in the fixation of the tibia in its abnormal position and the anteriorly luxated flexor tendons. Owen obtained complete reduction by a simple division of the quadriceps tendon. Wolff, in a case of complete luxation, lengthened the tendon by a plastic tenotomy and in addition, freed the tubercle and fastened it to a higher level with an ivory peg. Curtillet and Lombard in their cases followed somewhat the Wolff technique but stitched the tubercle to a higher level on the tibia. They advise the Wolff operation for obstinate cases, but emphasize the great necessity for a prolonged postoperative immobilization of the limb. In some cases it has been found necessary to incise the capsule or the iliotibial band before reduction can be accomplished. Arthrodesis should only be thought of in the extremely grave cases or in cases that have completed their full growth. In Reiner's case, a boy 8 years of age, the tibial plateau was gouged to fit the femoral condyles. Active flexion to 70 degrees was possible in seven months.

CASE REPORT

E. St. L., age 13 months, female. Family history: Parents are alive and well. One brother and one sister are living and well. No history of any congenital malformations either on maternal or paternal side of family. No history of any trauma or accident previous to the birth of the patient.

Present history. Was born spontaneously, after a moderate labor, in a frank breech presentation. There was noted no increase in the amount of amniotic fluid. Examination of the child immediately after delivery showed the thighs to be acutely flexed on the abdomen and the knees hyperextended to such a degree that the feet were brought in actual contact with head of the infant, a position described by the accoucheur as resembling the shape of a "jack-knife." The thighs could not be extended more than 30 degrees. Under progressive manipulation, the attending physician was able to increase the extension of the thighs, but as no improvement was made in the reduction of the deformity of the knees and as there seemed to be an increasing deformity of the feet, it was recommended that the patient go to the Children's Hospital for treatment.

Examination at that time showed a healthy, well-nourished infant of 5 months. Physical examination was negative except for the condition already described. Both thighs were held flexed 110 degrees, abducted 35 degrees. They could be brought to full extension but no hyperextension was possible. All other motion at the hips was normal. Both knees were held in hyperextension. On the right side flexion was possible only to a position repre-

sented by full normal extension; on the left side the knee could be flexed to 35 degrees. If, during an attempt to bring the limbs into normal position, they were released suddenly, the rebound to their vicious position (*phénomène du resort*) so characteristic of this condition, could be clearly demonstrated.

The patellæ could not be palpated. The right foot was in equino valgus, the left in equino varus. Any voluntary muscular movement of the infant tended to exaggerate the deformity, the thighs flexing acutely, the feet striking face or shoulders. This characteristic phenomenon had been frequently observed by the mother. Many X-rays of the knees were taken at this time and again later with a view to determining the exact relation of the articular surfaces of the bones entering into the formation of the joint. Figure 3 is a lateral view of the right knee taken at this time. It will be noted that the hyperextension of the knee is due to an actual forward slipping or subluxation of the tibial epiphysis on that on the femur. Nearly the whole of the anterior half of the epiphyseal cartilage of the tibia, which shows as a shadow around the ossific center, projects anterior to that of the femur, its articular surface out of normal relation to that of the femoral condyles. As a result the posterior articulating surface of the femoral condyles is also free.

The bayonet-like axial relation (*brisé en baïonnette*) characteristic of displacement is well shown here. If the longitudinal axis of the femur is prolonged so as to meet that of the tibia, in place of meeting to form an angle, a figure somewhat resembling a bayonet results. The anterior border of the femur is approximately in alignment with the posterior border of the tibia, another indication of displacement. There is no evidence of any epiphyseal separation or displacement contributing to the deformity. The patella, which may be seen as a thickening in the quadriceps tendon is situated higher than normally. It was not palpable clinically.

Under anæsthesia, the limbs were forcibly manipulated and a double plaster-of-Paris spica applied with the thighs fully extended, the knees flexed to as great a degree as was possible to obtain. During the corrective manipulations, no click suggestive of a sudden reduction of a subluxation or luxation was noted.

On January 2, 1916, a second manipulation, was done and the limbs again immobilized in further correction. The plaster was bivalved and the limbs massaged and manipulated daily. The patient was discharged from the hospital February 2, with condition greatly improved.

On June 4, 1916, the patient re-entered the orthopedic service. The treatment prescribed had been somewhat neglected and as the result the patient showed but little improvement over the condition noted when discharged from the hospital in February. Examination revealed the following condition: A well-developed, full sized infant, 11 months of age. With patient in dorsorecumbent position, both lower limbs project upward almost to right angles with the body axis. The thighs are held flexed 50 degrees on the abdomen and slightly abducted, but passively they may be extended to within 15 degrees of normal full extension. All other movement at hip normal. The knees are held in hyperextension, the leg forming an anterior angle of 160 degrees with the thigh. Passively the knee may be flexed to 50 degrees on the right and to 70 degrees on the left side. Further flexion causes pain to the child. Sudden release of a limb thus corrected, results in its immediate return to its vicious position but with a suddenness less marked than noted at earlier observations.

On the anterior surface of the knees, the cutaneous folds are plainly visible. There are two on the right, three on the left, the latter being especially well marked and deep. Flexion of the knee does not obliterate them. Careful palpation reveals the presence of both patellæ, not felt at earlier examinations. They are small and situated somewhat higher than normally.

Owing to the well-nourished condition of the infant and the presence of marked fat pads around the knee, one cannot determine the presence of any abnormal prominence of the tibial head anteriorly or the femoral condyles posteriorly. There is slight lateral mobility of the right knee with some abduction deformity.

The right foot shows a talipes equino valgus, the left a talipes equino varus. The valgus and varus are correctible, the equinus only so to a limited degree (Fig. 6).

Measurements of both limbs equal. X-rays reveal a relation of the articular surfaces similiar to that noted in the earlier plates but to a less marked degree. Figure 4 is a lateral view of the left knee taken in June, 1916. The degree of hyperextension is shown but the element of subluxation is much less marked than in the other plate. The patella is quite distinct and situated opposite the lower portion of the femoral diaphysis. The quadriceps tendon is relaxed as shown by its tortuosity, and apparently not responsible for the maintenance of the limb in its abnormal position. If the limb is flexed to 70 degrees, as may be possible, the tendon is tightened and the patella descends. With such direct evidence of the absence of the quadriceps as an obstacle to reduction, one may be justified in assuming the capsule or possibly a condition of anterior subluxation of the flexor tendons to be the causative element in the maintenance of the deformity. The presence of the cutaneous folds already described is clearly shown. On June 13, under ether, the knees were again manipulated and immobilized in plaster splints, in a position of further correction. In addition a tenotomy of both tendines Achillis with correction of the foot deformities was performed.

At the time of writing, the child has its limbs retained in corrective plaster-of-Paris splints which

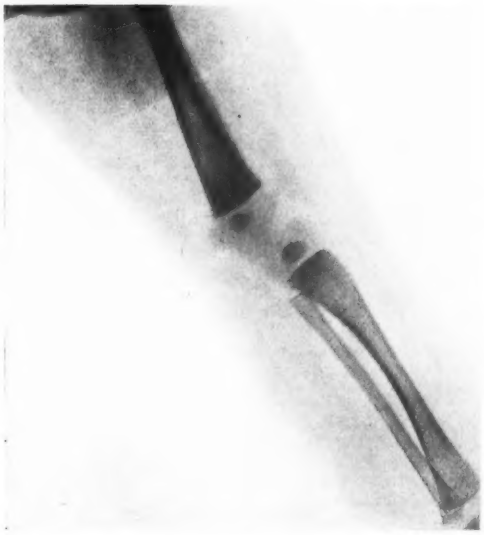


Fig. 3. Lateral view of right knee at five months showing the degree of hyperextension and the anterior subluxation of the tibia on the femur.

Fig. 4. Lateral view of left knee at 11 months. Note the height of the patella with the relaxed quadriceps tendon.

have been bivalved, so that they may be removed daily and the limbs massaged and manipulated. When last seen, flexion of the knees to 90 degrees was easily obtainable and the degree of hyperextension less marked.

En résumé, this patient presented at birth the condition of double congenital genu recurvatum combined with a marked congenital flexion contracture of the thighs on the abdomen, a talipes equino valgus of the right foot and a talipes equino varus of the left foot. The genu recurvatum is of *the type characterized by an anterior subluxation* of the tibia on the femur. There is no evidence of any epiphyseal separation or vicious union.

Treatment, consisting in progressive manipulations with and without narcosis, massage, and retention of limbs in corrective positions by means of plaster-of-Paris splints, has resulted in a gradual and encouraging diminution and correction of the deformities.

SUMMARY

A careful review of the literature has shown that the congenital malformation clinically shown as a hyperextension of the leg on the thigh may be represented anatomically by a condition ranging from a simple hyperextension with no element of luxation through all degrees of subluxation to an actual anterior luxation of the tibia on the femur; that in the majority of cases, the deformity is one of anterior subluxation in which the tibia is partially in front of the femur, often at the site of the displaced patella, the quadriceps shortened, the patella small and high, being situated on the anterior face of the lower end of the femoral shaft. The flexor tendons may be luxated forward to become extensors and in a few cases anteversion of the femoral epiphysis has been noted.

To attempt to designate a malformation represented by so many degrees of deformity by a term which is descriptive of but one type

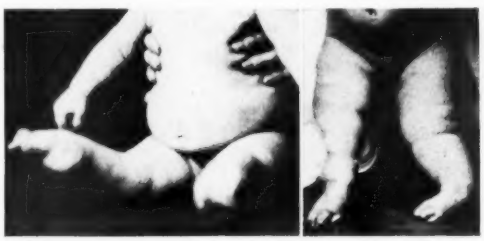


Fig. 5. Child at 5 months showing hyperextension. Flexion contraction of thighs on hips also present.

Fig. 6. Child at 11 months. Note the equino varus of left foot and equino valgus of right.

is obviously wrong. The terms anterior subluxation, anterior luxation and similar expressions proposed as generic titles for this malformation should be limited in their employment to the designation of the various types of the deformity recognized as *congenital genu recurvatum*.

The actual cause of the deformity is as yet undetermined but it seems probable that the condition is due to an abnormal prolonged retention of the limbs in an extended position during the period of differentiation of joints, a period when muscular power is low, and growth of the limbs is rapid, so that in the absence of normal flexion of the knees, a condition of hyperextension must result.

The prognosis is usually good and especially so in those cases where the earliest possible treatment is instituted.

Treatment in the mild cases consists in massage and corrective manipulations of the knees with retention in splints. Anæsthesia may be used if necessary. In more severe cases where the element of subluxation or luxation is present, reduction should be accomplished and followed by massage and progressive correction. In those cases where repeated attempts at reduction have been unsuccessful, open operation is indicated. This consists essentially in overcoming the obstacles to reduction and preventing the recurrence of the deformity.

In conclusion, the writer desires to express his appreciation to Dr. Robert W. Lovett for his kind and very valuable advice in the preparation of this report.

BIBLIOGRAPHY

1. Albert. Wien. med. Presse, 1857, No. 22, 474.
2. Ardouin. Rev. d'orthop., 1907, p. 193.
3. Bacillieri. Arch. f. Orthop. Mechan., etc., Wiesb., 1905, cxi, 213.
4. Bajardi. Cited by Potel and Drehmann.
5. Baker. Lancet, Lond., 1881, xi, 951.
6. Barth. Arch. f. klin. chir., 1884, xxxi, No. 3.
7. Bard. Boston M. & S. J., 1834.
8. Barwell. Lancet, Lond., 1877, p. 389.
9. Beely. Ztschr. f. orthop. Chir., 1892, Nos. 1 and 2.
10. Bertin. Union méd., 1889, p. 616.
11. Bilhaut. Ann. de chir. et d'orthop., 1902, No. 5, 129.
12. Bisping. Cited in Ztschr. f. orthop. Chir., 1903, xi, 880.
13. Blanc. Gaz. méd. de Par., 1884, p. 325.
14. Bloch. Prag. med. Wchnschr., 1892.
15. Bouvier. Bull. Acad. de méd., 1837, xi.
16. Brunner. Virchow's Arch. f. path. Anat. etc., Berl., No. 124, 1891.
17. Cayre. Thèse de doct., Par., 1900.
18. Chambrelent. Gaz. hebd. de sc. méd. de Bordeaux, 1897.
19. Chatelain. Biblioth. méd., lxxv, 103.
20. Cheyne. Lancet, Lond., 1890, xi, 924.
21. Conrad. Cited by Potel and Drehmann. Cor.-Bl. f. schweiz., Aerzte, 1875.
22. Cone. Am. Med., 1904, viii, 812.
23. Cordier. Presse méd. Belg., Brux., 1912, p. 473.
24. Cruveillier. Atlas de l'anatomie pathologique, 1849, vol. xi.
25. Curtillet and Lombard. Rev. d'orthop., 1912, p. 433.
26. Davis. Conservative Surgery, 1867, pp. 65-76.
27. Dechy. Thèse de doct., Lille, 1891.
28. Delanglade. Rev. d'orthop., 1903.
29. Delbet. Rev. d'orthop., 1908, p. 387.
30. Derocque. Rev. d'orthop. 1903.
31. Dowd. Ann. Surg., Phila., 1899, xx., p. 345.
32. Drehmann. Ztschr. f. orthop. Chirurgie, 1900, vii, No. 4; Handb. der orthop. Chir., 1905, p. 440.
33. Dubrisay. Le mouvement méd., Par., 1875, p. 299.
34. Florion. Le genu recurvatum congénital. Thèses de doct., Par., 1904.
35. Friedleben. Jarhb. f. Kinderh., 1860, cxi, 220.
36. Goodlee. Lancet, Lond., 1877.
37. Gray. Med. & S. Reporter, Phila., 1882, p. 222.
38. Guéniot. Bull. Soc. chir., 1870, p. 442.
39. Guérin. Recherches sur les deformitás congenital, 1841, p. 43.
40. Guermonprez. Ann. de chir. et d'orthop., 1900.
41. Habs. Muenchen. med. Wchnschr., 1905, No. 12
42. Hamilton. Traité des luxations. p. 1263.
43. Hartigan. Cited by Potel.
44. Heinecke. Beitraege zur. Kenntnis und Behandlung der Krankheiten des Knies. Danzig: 1866, p. 257.
45. Hibon. Luxation du tibia en avant. Thèse de doct., Par., 1881.
46. Hill. Brit. M. J., 1881, xi, 61.
47. Hilton. Cited by Potel.
48. Hofmokle. Cited by Potel
49. Holtzman. Virchow's Arch. f. path. Anat., etc., Berl., 1895, cxl., 322.
50. Joachimsthal. Freie Vereiniung der Chirurgen. Berlin: 1889, July; 1903, Jan.
51. Jolicoeur. Bull. Soc. méd. de Reims, 1873.
52. Jung. Arch. f. Orthop., etc., Wiesb., 1911, No. 1.
53. Karewski. Arch. f. Kinderh. vol. xii, 234.
54. Kirmisson. Rev. d'orthopédie, 1903, iv, 413; Traité des maladies chirurgicales d'origine congénitale, p. 584.
55. Kleeberg. Ztschr. f. d. ges. Med., von Diffenbach u. Frické Oppenheim, p. 1837, vi, 106.
56. Kocher. See Bacillieri.
57. Kofman. Arch. f. Orthop., etc., Wiesb., 1908, vi, 41.
58. Konigsen. Berl. med. Gesellsch., 1898, May 11.
59. Koerte. Deutsche Ztschr. f. Chir., 1877, vii, 63.
60. Knauer. Monatschr. f. Geburtsh. u. Gynaek., v.
61. Krogius. Jahresb. f. Chir., 1. Cited by Drehmann
62. Kroenlein. Thèse de doct., Zurich, 1812.
63. Krukenberg. Arch. f. Gynaek., 1885, xxv, 257.
64. Kuh. Prag. med. Wchnschr., 1902, No. 40, 517.
65. Kuestner. Arch. f. klin. Chir., 1880, p. 601.
66. Lannelongue. Cited by Potel.
67. Lefour. Gaz. hebd. d. sc. méd., de Bordeaux, 1896, No. 18.

68. Lipscomb, T. W. Austral. Med. Gazette, Sydney 1903, xxii, 568.
69. Maas. Arch. f. klin. Chir., 1874, xvii, No. 3; Langenbeck's Arch. f. klin. Chir., 1877, xvii, 492.
70. MacGillicuddy. J. Am. M. Ass., 1892, p. 107.
71. Magnus. Deutsche Ztschr. f. Chir., 1905, p. 555.
72. Mason. N. Y. M. J., 1876, p. 68.
73. Mayer. Am. J. Orthop. x, p. 411.
74. Mouchet. Arch. d. méd., d. enfants, 1905, No. 7, 385–397; Bull et mém. Soc. Anat., de Par., 1904, lxxix, 856.
75. Mueller. Arb. a. d. chirurg. Univ. Poliklin., Leipsig, 1888.
76. Muskat. Arch. f. klin. Chir., liv, 852.
77. Mutel. Rev. d'orthop., 1911, p. 303.
78. Myers. Orthop. Ass. N. Y., 1890, 111.
79. Nasse. Freie Vereinigung der Chirurgen, Berlin, 1895.
80. Nussen. Dissertation, Erlanger, 1891.
81. Owen. Lancet, Lond., 1891, p. 989.
82. Perier. Bull. de Soc. de chir., Paris, 1880, Dec.
83. Perthes. Ztschr. f. orthop. Chir., xlv, 629.
84. Phocas. Rev. d'orthop., Par., 1891, p. 50.
85. Plagemann. Congenital gelenkcontracturen. Inaugural Dissertation, Berlin, 1888.
86. Post. Med. Rec., N. Y., 1878, p. 408.
87. Potel. Étude sur les malformations congénitales du genou. Lille: 1897.
88. Pravaz. Cited by Sporri.
89. Rechman. Arch. f. Orthop., etc., Wiesbaden, xiii, No. 3.
90. Redard. Traité pratique de chir. orth., 1892, p. 537.
91. Reiner, Max. Ztschr. f. orthop. Chir., 1904, p. 442.
92. Richards, J. B. O. Lancet, Lond., 1898, p. 205.
93. Richardson and Porter. Boston M. & S. J., 1875, xi, 321.
94. Ridlon. Tr. Am. Orthop. Ass., 1896; Chicago Med. Rec., 1905, p. 1.
95. Roberts. Ann. Surg., Phila., xxxiv, 286.
96. Robertson. Glasgow M. J., 1884.
97. Rosenfeld. Ztschr. f. orthop. Chir., 1902, x, 149.
98. Von Salis. Deutsche Ztschr. f. Chir., 1908, xciv, 431.
99. Sanson. Cited by Phocas and Drehmann.
100. Sayre. Revue des maladies de l'enfant, 1890, p. 433; Med. Rec. N. Y., 1877.
101. Schmidt. Arb. a. d. chir. Univ.-klin., Leipsig, 1888.
102. Schoenfeld. Inaugural Dissertation, Berlin, 1865.
103. Sells. Brit. M. J., 1883.
104. Shattock. Tr. Path. Soc., Lond., 1891, p. 280.
105. Shields. Lancet, Lond., 1898, May 28, 1457.
106. Simpson. Brit. M. J., 1893, xi.
107. Skelton, E. W. Long Island M. J. 1910, p. 1024.
108. Smith. Michigan M. News, 1882.
109. Spoerri. Ueber die congenitale Luxations des Kniegelenk: Disseration, Zurich, 1891.
110. Tarnier. Bull. Soc. anat., Par., 1854, p. 109.
111. Taylor, H. Ling. Tr. Am. Orthop. Ass., 1896.
112. Taylor, S. T. Lancet, Lond., 1898, p. 1616.
113. Timmer. Cited by Potel.
114. Tridon. Revue d'orthop, 1905, Nov. 497–518.
115. Turner. Glasgow Obst. & Gynec. Soc., 1888, Nov.
116. Wachter. Deutsche Ztschr. f. Chir., 1913, June.
117. Wagner. Jahrb. f. Kinderh., 1866, viii.
118. Wehsarg. Arch. f. Orthop., etc., Weisb., 1905, cxi.
119. Weinlechner. Protok. d. Sitzung der K. K. Gesellsch. der Aerzte, Wein, 1884, Mar. 14.
120. Wolff. Ztschr. f. orthop. Chir., 1893, ii.
121. Wrede. Med. Klin., 1911, No. 1. p. 19.
122. Wutzer. Mueller's Arch. f. mikr. Anat. u. Physiol., 1835, p. 385.
123. Youmans. Boston M. & S. J., 1860, lxiii, 249.
124. Young, J. K. Univ. Med. Magazine, vol xi, 735.
125. Zesas. Rev. de chir., 1902, xxv, 455–479.

ACUTE INFLAMMATION OF THE NECK OF THE FEMUR[1]

By JAMES E. MOORE, M.D., F.A.C.S., Minneapolis
Professor and Chief of Department of Surgery, University of Minnesota Medical School

THE writer began his observations upon this subject more than twenty years ago, and nineteen years ago first called attention to the fact that the disease involves the neck of the femur on the diaphysial side, and that the separation of the head of the femur is due to the infection on the diaphysial side and not to an inflammation of the epiphysis, and suggested, therefore, that the term "epiphysitis" is a misnomer.

MacNamara suggested the name of "acute epiphysitis" in the first edition of his classic work on diseases of the bone; but in the third edition, published in 1887, he states that exception has been taken to the term epiphysitis because in many of the cases the diaphysis is entirely destroyed but the epiphysis continues to live and grow. He states, however, that the objection is somewhat fallacious, because the epiphysis is acutely inflamed in these cases and is not destroyed because its blood supply is independent of that of the diaphysis. The writer has demonstrated that the real infection in these cases takes place invariably on the diaphysial side of the epiphysial line in this disease, just as it does in osteomyelitis in other locations, and

[1] This paper is a sequel to one published in the *Annals of Surgery* for April, 1916, under the title of "Osteomyelitis Involving the Hip-Joint, a Condition Heretofore Erroneously Designated Acute Epiphysitis."

that the free blood supply of the epiphysis protects it from infection.

In every one of the many cases operated upon by the writer the disease has been limited to the neck of the femur, and in a few in which the diagnosis has been made early and drainage established, the disease has been cured and the epiphysis has not been separated. The majority of cases have come under observation after the disease had made some progress, and after separation of the epiphysis had taken place, not because of inflammation in the epiphysis itself, but because of the disease on the diaphysial side in the neck of the femur.

In the previous paper, already mentioned, apology was made for the use of the term "osteomyelitis involving the hip-joint," because there is no medullary cavity in the neck of the femur, and in casting about for a suitable name for this disease Dr. C. M. Jackson, Professor of Anatomy in the University of Minnesota, was first consulted, who stated that the term "osteomyelitis of the neck of the femur" is not necessarily incorrect, as the spaces of the cancellous tissue of the neck of the femur contain marrow which may be involved, and suggested that this is a matter for the pathologist to decide. Dr. Jackson suggests as a possible substitute for the term "epiphysitis," *femoral apophysitis*, since the neck of the femur being an outgrowth from the shaft of the femur is an apophysis, and cites a precedent already established by the term *apophysitis tibialis adolescentium* or Schlatta's disease.

Dr. H. E. Robertson, Professor of Pathology in the University of Minnesota, states that the term "osteomyelitis of the neck of the femur" is not pathologically incorrect, for, although there is no definite medullary canal in the neck of the femur, there are red marrow-cells all through it which may be the seat of an infection, so that on the whole the term "osteomyelitis of the neck of the femur" seems to the writer to be the most distinctive title because it states clearly just what the condition is, and the clinical history of this disease is exactly that of osteomyelitis elsewhere.

Most writers in discussing this disease speak of it as a rare one, but the writer's experience leads him to believe that its apparent rarity is due to the fact that it is so commonly overlooked, for he has constantly under observation patients suffering from this disease. At the present time we have three cases in the University Hospital, and we have had five in one month. Of all the cases of this disease admitted to the University Hospital, in only one has a correct diagnosis been made before admission, and that one was seen by Dr. Law, a member of our hospital staff.

The fact that the neck of the femur is deep-seated makes the diagnosis somewhat more difficult than it is in the average case of osteomyelitis. The prognosis is much more grave, because the disease is so located that when Nature relieves the pressure in the center of the neck of the femur by breaking through the shell of bone into the surrounding parts, the infecting material necessarily breaks into the hip-joint, and we have added to the original disease suppurative synovitis of the hip-joint. In the writer's experience the disease has always occurred before the eighteenth year of age and during the time of development and growth of bone.

CLINICAL HISTORY

For convenience of study the writer deems it wise to divide this disease into three classes: the very acute; the medium, or average type; and the subacute, this division resting entirely upon the severity of the disease, because the pathology is alike in all cases.

Fortunately, the majority of cases are of the second class, that is of *medium severity*, which we will now describe. The disease begins with pain in the hip-joint extending down the thigh, is frequently accompanied by a severe rigor which is promptly followed by profuse sweating and rapid rise of temperature, usually up to 104°. Within forty-eight hours there is a certain amount of effusion into the hip-joint, the inguinal fold is partly obliterated, and a difference in the contour of the two sides is quite noticeable, and sometimes there is marked swelling of the upper part of the thigh. The patient holds the afflicted limb flexed and abducted,

and objects to any effort to move it. There is marked leucocytosis, and the polymorphonuclears run high. Blood examination is usually negative. The urine may show slight amount of albumin, but is usually negative. The roentgen examination at this time is negative.

The subacute variety. It should be remembered that this disease may be so mild from the outset that a very careful examination is required to make a diagnosis, and the disease is very liable to be overlooked. But even in these mild cases the tendency is for the disease to go on and destroy the neck of the femur, separate the epiphysis, and to involve the hip-joint, and although the danger to life is not nearly so great, the final result is apt to be just as disastrous to the joint as in a case where the disease is more acute.

The acute type. In this class of cases the infection is so overwhelming that the patient becomes delirious, his life is in jeopardy, the hip-joint is destroyed at a very early stage, and there is a marked tendency for a dissemination of the disease to other bones and joints. We have two such cases in the University Hospital at the present time, and one was admitted last month who died within a few hours from general sepsis, although the disease had existed but five days. This type is particularly prevalent among young children, and the delirium comes on so suddenly that it is very apt to obscure the symptoms and make the diagnosis particularly difficult. In this type blood culture will frequently show streptococci and occasionally staphylococci.

DIAGNOSIS

In the average case a diagnosis can be made by a careful observer without great difficulty. The clinical history as already told should lead to a careful physical examination. Notwithstanding the fact that the joint is exquisitely sensitive and the patient objects to having the limb handled, a skillful hand can gently manipulate the joint in such a manner as to determine whether the head of the femur is still attached and whether it moves normally in the acetabulum. A careful examination of the bones of the healthy leg should be made first, for sake of comparison and in order to gain the patient's confidence. To make an accurate diagnosis early it is necessary to take advantage of the well-known fact that at a very early period the periosteum immediately over the central focal infection becomes exquisitely sensitive. The surgeon should grasp the tibia of the afflicted side gently between his thumb and fingers, making pressure upon the periosteum of the tibia so as to exclude osteomyelitis of that bone. He should then grasp the femur just above the condyles, making gentle pressure upon the periosteum with his thumb and fingers. He should very carefully follow up the shaft of the femur and he will find that he can make direct pressure on the periosteum throughout the length of the femur without causing pain. At an early date he may even make pressure directly over the great trochanter, crowding the head of the bone into the acetabulum without causing pain. If he will then pass one hand underneath the patient so that the points of his fingers rest over the hip-joint posteriorly and will make pressure over the anterior surface of the joint with his other hand, pinching the neck of the femur between the ends of the fingers of the two hands, the patient will immediately cry out on account of the severe pain, and the diagnosis is unquestionable.

In every case where a child becomes suddenly delirious, with high temperature, and is evidently suffering pain, the doctor should observe the patient's attitude, bearing in mind that a very acute osteomyelitis often begins in this manner. When one of the extremities is held in a flexed and abducted position, the whole extremity should be carefully palpated as previously described, and even in delirious patients, when direct pressure is made over the diseased point, the patient gives unmistakable evidence of increase in pain. Unfortunately, a roentgen examination is not helpful in the very early stages of the disease. Figure 1 is a roentgenogram of the limb of a patient who had an abscess in the neck of the femur, but there is no evidence of it in the picture. Later in the disease roentgenograms are very helpful.

PROGNOSIS

In the average case the prognosis for both life and limb is remarkably good, provided the diagnosis is made promptly and proper treatment applied. In the very acute cases the danger to the patient's life is very great because of the marked tendency to a general dissemination of the disease. The danger to the joint is also great because the difficulties of diagnosis are such that the neck of the femur may be destroyed and the epiphysis separated before a diagnosis is made. In the milder type of cases the prognosis is good, again provided the diagnosis is made within a reasonable time. The great danger in this type of cases is that owing to the extremely mild course of the disease the diagnosis may not be made until the head of the femur has been separated. In the writer's former paper a case was cited in which the disease developed in a patient while in the hospital suffering from osteomyelitis of the tibia, but the symptoms were so mild that special attention was not drawn to the hip until separation of the epiphysis had taken place. In some of the mild cases in which the diagnosis has not been made and the proper treatment has not been applied, Nature may relieve the patient by breaking through the soft parts, allowing escape of pus. Those cases are usually pronounced tubercular, but when the operation is made the neck of the femur will be found necrotic, the epiphysis floating loose in the joint, and the patient will make a wonderfully prompt recovery after the operation. When the trochanters are preserved, as they always should be when operating for this disease, Nature usually establishes a remarkably good artificial joint by bringing the upper end of the femur close to the acetabulum and attaching it there.

TREATMENT

The treatment is prompt and efficient drainage of the affected part. In our experience the most satisfactory results have followed drainage directly through the joint from the front, and opening into the neck of the femur just as would be done were the disease in the lower end of the femur. MacNamara suggested that we should make an incision over the great trochanter and drill through the trochanter into the center of the neck of the femur and drain the infected part so as to prevent infection of the hip-joint. In one of the cases reported in this paper early diagnosis was made and MacNamara's operation performed. An abscess was found in the center of the neck of the femur and drained through this opening through the trochanter. Notwithstanding the fact that there was no evidence of infection of the hip-joint at the time of this operation, the drainage through this trochanteric opening was insufficient and the joint later became infected and was drained before the head of the bone had become separated.

With the patient lying supine, an incision should begin just below the anterosuperior spinous process of the ileum and extend downward between the inner margin of the tensor vaginæ femoris and the outer margin of the sartorius. The vessels are well to the inner side of this incision and are in no danger. Blunt dissection should then be made down to the capsule of the joint, and the parts well separated by blunt retractors. Even at a very early stage of the disease the soft parts in front of the joint are usually œdematous, and the surgeon realizes early in his operation that he is approaching the center of infection. A free opening should then be made through the anterior wall of the capsule of the joint, and the neck of the femur carefully examined by the surgeon's finger. The condition of the joint will depend entirely upon the stage of the disease. At a very early stage there may be little or no change in the joint, or there may be some effusion of serum. At a little later stage the joint capsule will be distended with pus. At a still later stage the neck of the femur will be found necrotic and the head of the bone separated.

In the very early case, notwithstanding there is no evidence of infection in the joint, the surgeon should unhesitatingly make a drill-hole directly into the neck of the femur, well toward the epiphysial line. This drill-hole should be large enough to admit the introduction of a reasonable sized rubber

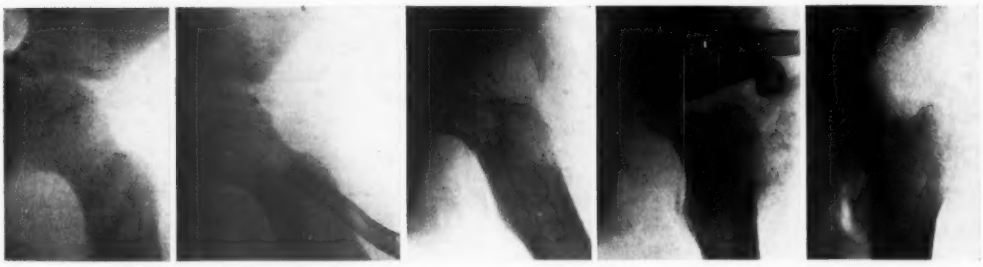


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5.

Fig. 1. Roentgenogram, Case 1, taken May 16, 1916. The patient had an abscess in the neck of the femur which is not found in the picture.

Fig. 2. Case 1. Roentgenogram taken May 17, after operation. Drainage tube inserted.

Fig. 3. Case 1. taken June 22, after third operation.

Fig. 4. Case 1. Roentgenogram taken June 22 after third operation. Rubber drainage tubes introduced and Buck's extension applied.

Fig. 5. Case 1. Roentgenogram taken when patient left hospital, September 2, showing regeneration of bone and the epiphysis in its normal position.

drainage tube. At this very early stage, the surgeon may find little evidence of infection, but his patient will be relieved and the temperature will drop immediately, as beautifully illustrated in one of the cases reported in my former paper. We all know that in cases of osteomyelitis in other locations when we operate at a very early stage we may not find pus in the medullary cavity, but that our patients are promptly and permanently relieved of their pain and temperature by the operation, and we have demonstrated that the same holds true in this operation. In the early cases a rubber tube should be passed into the drill-hole in the neck of the femur and fastened in this position. The joint capsule is then loosely closed about the tube and the wound closed.

In cases farther advanced, where there is already necrosis in the neck of the femur, but in which the epiphysis has not yet been separated, the sequestra should be removed and drainage established. At a still later stage when the epiphysis has been separated, it should be removed together with the diseased portion of the neck. The trochanters should not be removed as they are in tuberculosis of the hip, because they are not involved in the disease and will be helpful in establishing an artificial joint. It is the exception when these patients recover after a single operation. They must be watched carefully and additional drainage established whenever a decided rise of temperature occurs.

The following cases coming under the writer's observation in the University Hospital within the past few months will illustrate the various points made in the paper.

Case 1. This case is of the medium or average type. On May 16, 1916, H. M., age 11, was admitted to the medical side with a tentative diagnosis of rheumatism. His previous history was negative. On May 12, four days before admission, he awakened with severe pain in the right groin just below Poupart's ligament in the region of Scarpa's triangle. He got up and was about that day until noon, when he went to bed, where he had been up to the time of admission. After going to bed he had a severe chill followed by sweating. He lost his appetite and was unable to sleep. There was flexion and abduction of the thigh with slight swelling over the hip-joint in front. Physical examination demonstrated that by careful manipulation the joint could be moved in all directions, and that there was evidently no separation of the head of the femur. Direct pressure over the neck of the femur caused excruciating pain. A roentgenogram (Fig. 1) was negative. His temperature on admission was 102.8°; pulse 110. There was nothing of special interest in the urine; leucocytosis 12000; polymorphonuclears 72 per cent. A diagnosis of acute osteomyelitis of the neck of the femur was made by Dr. Corbett. On May 17, the fifth day of the disease, the patient was admitted to the surgical ward. His temperature was 103.9°, and his pulse 112. On the same day he was operated upon under ether anæsthesia by Dr. Corbett. An incision was made over the great trochanter and a bone drill passed through the trochanter along the center of the femur. After passing into the bone about two and a half inches, an abscess containing about one ounce of pus was found. A rubber drainage tube was introduced (Fig. 2).

The next morning his temperature was 100.5°,

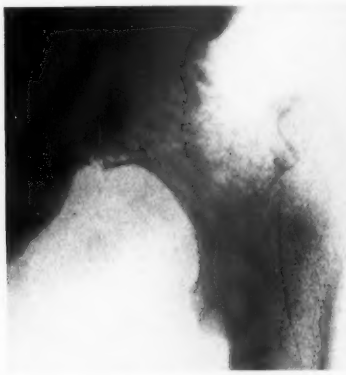


Fig. 6 (at left). Case 2. Roentgenogram taken June 20, showing marked destructive process of the neck of the femur as far as the epiphysis. No evidence of sequestra.
Fig. 7 (at right). Case 2. Roentgenogram taken immediately after operation.

and his pulse 88. After this his temperature and pulse fluctuated from day to day, showing that the drainage was insufficient. On May 26, the patient was given an anæsthetic, the drainage opening cleaned out and the tube replaced. On June 1 it was evident that there was somewhere a lack of drainage. He was again taken to the operating-room and operated upon by Dr. Corbett, who found an abscess in the soft parts on the inner side of the thigh, which was opened and drained, and the tube replaced in the old trochanteric wound. On June 22 his temperature again went up to 102.2°, and his pulse to 115. There was evidence of effusion into the hip-joint. He was again taken to the operating-room, and in the absence of Dr. Corbett, Dr. Strachauer did an anterior arthrotomy, opened the distended hip-joint and evacuated a quantity of yellow pus. Several large sequestra, constituting from one-half to one-third of the neck of the femur, were removed and a small spot in the head of the femur scooped out. Separation of the epiphysis had not taken place. Rubber drainage tubes were introduced, and Buck's extension applied (Figs. 3 and 4). Pulse and temperature gradually improved until they became normal.

He was finally discharged on September 2, 1916, having been in the hospital 108 days. His wounds were healed, and there was quite free motion in the hip-joint with some limitation of flexion and abduction. He was walking about comfortably on crutches, and his general health was good. He had been cautioned not to place any weight on the limb for fear of fracture of the neck. The roentgenogram taken just before the patient left the hospital shows regeneration of bone, and the epiphysis in its normal position (Fig. 5).

CASE 2. This case is of the milder type. E. S., age 17, a farm-hand, was admitted to the University Hospital on June 19, 1916, with a tentative diagnosis of osteomyelitis *without special localization*. Previous history was unimportant. Five weeks before admission to the hospital he awakened one morning with extreme pain in the right hip, so that he could not get out of bed. Two days later he was better and went to town to consult a doctor. Two or three times during the week before admission he had been delirious for a few minutes at a time. Pain was so severe at this time that a sedative was administered. Patient states that he could stand on the foot for a time after the beginning of the trouble, but it caused him pain, and his right knee was tender. The pain was continuous, and after the first week was worse at night. He had night sweats during the five weeks preceding his admission and was losing weight rapidly. Upon admission his temperature was 101.8°, and pulse 118, and the next day, June 20, the day of the operation, his temperature was 101.2°, and pulse 120. Urinalysis was negative. Hæmoglobin 83 per cent; leucocytosis 18,000; polymorphonuclears 87 per cent. Roentgen report: Marked destructive process of the neck of the femur as far as the epiphysis. No evidence of sequestrum. (Fig. 6.) The patient was confined to bed, unable to move, face pinched giving the appearance of one in great pain. Body covered with perspiration. Diffuse macular rash over abdomen and chest; one eroded area the size of a dollar over the head of the left femur; another over the crest of the ilium; one slightly eroded area over the sacrum, evidently bed sores. The leg is most comfortable when arched over a pillow; severe tenderness when moved. Entire femur is very tender from sacrum to knee-joint, maximum over the neck of the femur. Rotation is limited by muscular spasm. Hip-joint is very tender.

A diagnosis of osteomyelitis of the neck of the femur was made by Dr. Strachauer, and was based upon the general history, localized tenderness over the neck of the femur, and the roentgen report. On June 20 he was operated upon by Dr. Strachauer,

who opened the right hip-joint anteriorly, found complete distintegration of the neck of the femur and separation of the head. The sequestrated neck and the head of the femur were removed. Rubber tubes were introduced into the hip-joint cavity, and Buck's extension applied (Fig. 7).

On the 21st, the day after the operation, the patient's temperature was normal, and pulse 100. Since that time he has had a fluctuating pulse and temperature but never extremely high, and he has been gradually convalescing. He is still in the hospital, with practically normal pulse and temperature, wound almost closed, and is walking about on crutches with over an inch of shortening.[1]

CASE 3. This case illustrates the very acute type. F. K., age 10, admitted as an emergency to the University Hospital on September 20, 1916. Temperature was 102.6°, pulse 152, leucocytes 8000. Patient semicomatous. His physician states that on the 18th, two days before admission, his temperature was 105.4°, and that he had a leucocytosis of 30,000. The patient had been seen by Dr. Sedgwick and Dr. Law on the 18th, who made a diagnosis of acute osteomyelitis of the neck of the femur, which was confirmed by the writer upon the patient's admission to the surgical ward. The limb was flexed and slight swelling could be detected over the right hip-joint. Notwithstanding the patient's mental condition, excessive pain could be elicited by pressure immediately over the neck of the femur. The emergency was so great that a complete history could not be obtained, but it was ascertained that the child had been taken ill on September 16, four days before admission to the hospital. A representative of the City authorities had pronounced the case one of poliomyelitis. The patient was taken to the operating-room promptly, where he was operated upon by Dr. Law, who made an incision over the front of the joint at the point of election, opening the capsule. An abscess was found underneath the periosteum in front of the neck of the femur near the epiphysis, containing about 30 cubic centimeters. An opening was drilled into the neck of the femur, and the joint drained. As blunt dissection was made through the soft parts, marked œdema was noticeable. The child died within a few hours.

Notwithstanding the desperate condition of this patient when he was admitted, the writer believes that operation was justifiable, because he has seen patients, particularly young children, recover from seemingly like conditions after drainage of the joint.

Blood examination and the pus removed from this case both showed staphylococci. At the post-mortem the focus in the neck of the femur could not be demonstrated by gross examination, but pathologists have demonstrated that we do not have suppurative periostitis except when secondary to infection in the center of the bone. Involvement of the pericardium and of both pleural cavities was found, but these were evidently secondary, because the child's complaint had been of the hip-joint from the very first.

[1] The patient has since been discharged with a remarkable amount of motion in the hip-joint, and every promise of a useful false joint.

RESULTS OF SURGICAL TREATMENT OF GASTRIC ULCER[1]

BY DONALD C. BALFOUR, M.D., F.A.C.S., ROCHESTER, MINNESOTA

THE surgical treatment of gastric ulcer should not be undertaken with a preconceived idea of the type of operation to be performed. Any routine method of dealing with benign lesions of the stomach is neither intelligent surgery nor a contribution toward further progress in the treatment of diseases of the stomach. Although evidence is conclusive that surgery gives permanent relief in a higher percentage of cases and with less associated risk than any other therapeutic measure, it is also true that the surgical treatment of gastric ulcer may be made still more efficient. Although I am quite aware that other factors than operative technique should be considered, the main purpose of the present paper is to present the result of an investigation to determine the relative merits of the various operative procedures employed in the treatment of gastric ulcer.

The conclusions are based on 677 gastric ulcers operatively demonstrated in the Mayo Clinic during the past ten years. No consideration has been taken of ulcers of doubtful situation. Even "pyloric lesions" in which the ulcer has not been positively located on the gastric side of the pylorus have been excluded as have been also acute perforated ulcers and those which after removal exhibited evidence of early malignant change.

The impression that the results of opera-

[1] Presented before the Western Surgical Association, St. Paul, Minnesota, December 15, 1916.

tion vary to a large degree with the situation of the ulcer having been confirmed, it was necessary, in order to obtain a fair estimate of results, to classify gastric ulcers into the following groups:

1. Ulcers near the pyloric outlet.
2. Ulcers on the lesser curvature.
3. Ulcers on the posterior wall.
4. Ulcers on the anterior wall.
5. Ulcers producing hour-glass contraction.

Certain principles hold true in the treatment of all gastric ulcers. While the frequency with which gastric carcinoma is preceded by ulcer may be a basis for argument, it must again be emphasized that gastric ulcers do at times become carcinomata. The premise, therefore, that gastric ulcer should, if possible, be excised or destroyed may be accepted as logical. The routine adherence to such a principle, however, is difficult from a technical standpoint and the absence of positive signs of malignant change may persuade the surgeon, against his better judgment, to base his treatment on the assumption that there is no malignancy. Although fully recognizing the importance of the removal of the ulcer-bearing area because it is a potentially malignant lesion, we must also bear in mind the fact that malignancy with comparative rarity develops in a gastric ulcer for which gastro-enterostomy alone has been done.

Unfortunately, there is no certain method of consistently determining early malignant invasion of an ulcer. In some instances valuable suggestive evidence is found in the history of the patient, the X-ray findings, and the chemical characteristics of the gastric juice, while in others positive proof is obtained by gland examination. The transitional stage between ulcer and cancer cannot be detected at the operating table, and a segment of the ulcer excised for examination may not demonstrate malignant change although cancer-cells may be present in other portions of the base.

The extent of the induration and the degree of its activity must be taken into careful consideration in arriving at a decision as to the operation of choice. An inflammatory mass of large size with gross evidences of subacute perforation as a rule precludes excision or resection, while perigastric extension sufficient to involve other organs, such as the liver or pancreas, should usually be a warning against attempted removal.

1. *Ulcers in the pyloric outlet.* In this group there were 197 ulcers, 29 per cent of the total. It seems to be indisputable that ulcers close to the pylorus are more readily amenable to successful surgical treatment than those in any other portion of the stomach (Brewer, 1; Woolsey, 2; and others). Particularly when mechanical obstruction has occurred from contraction of the ulcer or by reason of its actual size, operation is followed by eminently satisfactory results. The technical difficulties incident to the removal of such ulcers are less than those encountered with other gastric ulcers but their surgical treatment demands more mature judgment as to the correct operative procedure to follow. It is difficult, for example, to determine whether early malignant change has occurred in such ulcers, and inasmuch as usually the pyloric end of the stomach, including the ulcer area, can be resected without prohibitive added risk, considerable responsibility is assumed in deciding that a suspicious lesion at the outlet is not malignant. Conversely the decision that a lesion is malignant may mean an unnecessary resection. When long-continued obstruction has produced a degree of emaciation which permits of only a gastro-enterostomy, the error of assuming the growth to be malignant may result in an unnecessary pylorectomy later. It is in this type of case also that occasionally a hopeless prognosis is given to the patient, and in which a palliative gastro-enterostomy for the supposed extensive carcinoma is followed not only by relief of symptoms, but by a return to permanent good health.

The relative frequency of operations from January 1, 1906, to November 1, 1916, for gastric ulcers near or involving the pylorus is shown in Table I.

2. *Ulcers on the lesser curvature.* These comprised 316 of the gastric ulcers, 46.6 per cent of the total, being thus considerably the most common type, especially in view of the

TABLE I

	No. of Cases	Per-centage
Posterior gastro-enterostomy	105	53
Pylorectomy (Rodman, Billroth, No. 1, Polya, and others)	41	20
Excision and pyloroplasty	12	6
Cautery and gastro-enterostomy	11	5.5
Anterior gastro-enterostomy	10	5
Pyloroplasty	8	4
Excision and gastro-enterostomy	7	3.5
Excision	1	0.5
Reinforcement	1	0.5
Closure	1	0.5
Total	197	

fact that many of the ulcers classified in the preceding group, i. e., ulcers in the pyloric outlet, developed on the lesser curvature. Their tendency to localize on the lesser curvature and to spread on to both anterior and posterior walls of the stomach accounts for the term "saddle ulcer." It has been our experience, however, that such ulcers tend to extend to the posterior wall rather than to the anterior wall. These ulcers frequently illustrate in a marked degree the discrepancy in size between the area of induration and the actual crater of the ulcer. It was in these lesser curvature lesions that the cautery was first employed as a surgical measure. A sufficient number of patients have now been operated on by this method to prove its safety and efficiency, and our own observations have been confirmed by others, particularly Scudder and Harvey (3).

Lesions are repeatedly found in which excision would be inadvisable and of decided risk on account of the wide area of induration and of the inaccessability of the ulcer due to its high situation on the lesser curvature, but in which complete destruction of the crater of the ulcer can be accomplished with the cautery. For lesser curvature ulcers the operations shown in Table II were performed.

3. *Ulcers on the posterior wall.* There were 63 ulcers on the posterior wall, constituting 9.8 per cent of the series. These have an added surgical interest, since, with the problem of the local treatment of ulcers, various routes to gain access to the ulcer may be chosen by the surgeon; e. g., through the gastrohepatic omentum, through the mesocolon, by separation of the omentum from the transverse colon (Pauchet, 4), or

TABLE II

	No. of Cases	Per-centage
Posterior gastro-enterostomy	93	26.6
Excision	72	20.6
Cautery and gastro-enterostomy (two years)	62	17.7
Excision and gastro-enterostomy	37	10.6
Pylorectomy	20	5.7
Gastrogastrostomy	14	4.0
Anterior gastro-enterostomy	11	3.0
Sleeve resection	10	2.8
Pyloroplasty	8	2.0
Cautery and pyloroplasty	7	2.0
Excision and pyloroplasty	7	2.0
Jejunostomy	3	0.8
Exploration	2	0.5
Suture compression	2	0.5
Reinforcement	1	0.2
Total	349	

through the anterior wall of the stomach. If the crater of the ulcer is not of large size, and there is little evidence of peritoneal irritation about the ulcer area, its excision may be attempted. Even if the ulcer has perforated into the pancreas, it may be still possible and safe to separate the stomach from its resulting attachment, trim out or sterilize the edges of the ulcer, and close the defect. The operations shown in Table III were used in this group.

4. *Ulcers on the anterior wall.* Ulcers on the anterior wall constitute a relatively small group, there being but 17 in the series, 2.5 per cent of the total. Such ulcers are easily excised by knife or cautery unless perforation has occurred with attachment to the anterior abdominal wall. Table IV gives the operations performed in this group.

5. *Ulcers producing hour-glass contraction.* In the group of ulcers producing hour-glass contraction are 58 cases. The characteristic deformity warrants a separate classification although the contraction may be produced by an ulcer of the anterior or posterior wall or an ulcer of the lesser curvature. These are most interesting from a surgical standpoint for they tax the resourcefulness and skill of the surgeon and stimulate his ingenuity.

A wide variety of operative procedures are at the choice of the surgeon, the selection being governed by the condition of the patient, the pathologic findings, and the capability of the surgeon. The ulcer which has produced the deformity may be so situated

TABLE III

	No. of Cases	Per-centage
Posterior gastro-enterostomy	17	21.0
Pylorectomy	10	12.5
Excision and gastro-enterostomy	8	10.0
Gastrogastrostomy	8	10.0
Pyloroplasty	6	7.5
Cautery and gastro-enterostomy	6	7.5
Anterior gastro-enterostomy	5	6.0
Excision	5	6.0
Jejunostomy	4	5.0
Cautery and pyloroplasty	4	5.0
Excision and pyloroplasty	2	2.5
Sleeve resection	2	2.5
Reinforcement	2	2.5
Closure	1	1.2
Total	80	

TABLE IV

	No. of Cases	Per-centage
Excision	6	25.0
Pylorectomy	5	20.8
Cautery and gastro-enterostomy	5	20.8
Pyloroplasty	3	12.5
Posterior gastro-enterostomy	2	8.3
Excision and pyloroplasty	2	8.3
Jejunostomy	1	4.0
Total	24	

that resection of a complete segment including the ulcer and the scar may be possible. This operation, which entails an end-to-end union of the resected stomach, has given excellent results in our hands, and has been reported upon favorably also by others (Haines, 5).

It has been recently shown by Stewart and Barber (6) that after "sleeve resection" the motility of the stomach more nearly approximates the normal than it does after resection of a V-shaped segment from the lesser curvature.

However, this, or in fact any type of resection, is not always possible, for the ulcer may have become so firmly fixed that the stomach cannot be mobilized, under which circumstances drainage must be procured either by gastrogastrostomy or by gastro-enterostomy on the proximal or distal segment of the stomach. Should the ulcer be situated on the anterior wall, and should the greater part of the scar be accessible, satisfactory results may be obtained from excision of the ulcer, or from puncture with the cautery point and correction of the original deformity by a gastroplasty.

The operations which have been done in the Clinic for hour-glass contractions are given in Table V.

In the compilation of these statistics, the mortality records detail important information as to the relative risk of the various types of operation as well as the risk according to the situation of the ulcer.

In Tables VI and VII, although there are several figures to which I might allude, I would draw attention to the fact that in 87 operations by the cautery method combined with gastro-enterostomy there was one death. Moreover, in the case of this patient a double operation was done, the primary operation being cholecystectomy for a septic gall-bladder in the subacute stage. The necropsy report stated that the stomach was in perfect condition and that the cause of death was septic cholangitis.

In considering the results of the various operations employed in the treatment of gastric ulcer, it would be advisable to state the basis on which these results were compiled. The information was obtained through a form letter sent to each of the patients operated on in the Mayo Clinic for gastric ulcer from January 1, 1906, to July 1, 1915. The letter was so constructed that we believe we have obtained an accurate estimate of the result of the operations, for inasmuch as they were performed primarily for the relief of subjective symptoms the patients become the final arbiters as to the success of the treatment. It has further been our experience that those failing to reply to inquiries of this kind are likely to be enjoying good health. It should be noted that at least a year and a half has elapsed since the last case considered in this report. Criticism may be offered that the present health of the patients operated on as recently as 18 months ago is not a criterion of the late results, but experience has shown that a recurrence of symptoms rarely develops after the patient has had relief for a year. It is also a fact that in the event of such recurrence it is due probably to the development of a new ulcer rather than to a failure to cure the original ulcer.

The results of operation in all cases of gastric ulcer are tabulated in Table VIII.

TABLE V

	No. of Cases	Per-centage
Gastrogastrostomy	22	39.0
Posterior gastro-enterostomy	8	13.8
Pyloroplasty	8	13.8
Sleeve resection	4	6.7
Cautery and gastro-enterostomy	4	6.7
Pylorectomy	4	6.7
Anterior gastro-enterostomy	2	3.4
Jejunostomy	2	3.4
Excision	2	3.4
Excision and pyloroplasty	2	3.4
Total	58	

TABLE VI.—A SERIES OF 670 GASTRIC ULCERS ACCORDING TO TYPE OF OPERATION

(January 1, 1906, to November 1, 1916)

	Oper-ations	Mor-tality	Per-cent-age
Posterior gastro-enterostomy	228	4	1.7
Cautery and gastro-enterostomy	87	1	1.1
Excision	84	4	4.7
Pylorectomy	77	6	7.7
Excision and gastro-enterostomy	52	2	3.8
Anterior gastro-enterostomy	27	1	3.7
[1] Pyloroplasty	26	2	7.0
[1] Excision or cautery and pyloroplasty	35	3	8.5
Gastrogastrostomy	23	1	4.3
Sleeve resection	12	..	0.0
Miscellaneous	10	0	0.0
Jejunostomy	8	1	12.5
Total number reported in this series	670	24	3.5

[1] This mortality is not representative of pyloroplasty by the Finney method, which in our experience in ordinary cases has given a mortality of less than 3 per cent. The group of cases in which the operation was performed included a number of poor surgical risks, with extensive local disease, so that the operation was often one of expediency rather than one of choice.

TABLE VII.—A SERIES OF 670 GASTRIC ULCERS ACCORDING TO POSITION

(January 1, 1906, to November 1, 1916)

	Cases	Per-cent-age	Mor-tality	Per-cent-age
Ulcers on the lesser curvature	349	52	12	3.4
Ulcers close to or involving the pylorus	197	29	3	1.5
Ulcers on posterior wall	80	12	6	7.5
Ulcers on anterior wall	24	3.5	1	4.0

The percentages are based on information from 285 patients who were operated on previous to July 1, 1915. Deaths which occurred months or years after operation are excluded in this report, but are being carefully investigated and will undoubtedly contribute much desired information as to the life expectancy and the possibility of the development of cancer as well as other fatal late complications in those operated on for gastric ulcer.

TABLE VIII.—RESULTS OF OPERATIONS FOR GASTRIC ULCERS

(From January 1, 1906, to July 1, 1915)

		Per-centage
Total number of patients heard from	285	
Cured	159	55.7
Greatly improved	65	22.8
Slightly improved	28	9.8
No better	33	11.5
Satisfactory results	224	78.9

TABLE IX.—RECAPITULATION

	Operations	Satis-factory Results, Per-centage	Operative Mortality, Per-centage	Secondary Operations, Per-centage
Posterior gastro-enterostomy	228	84	1.7	1.8
Pylorectomy	77	90	7.1	3.9
Excision and posterior gastro-enterostomy	52	83	3.8	3.9
Cautery and posterior gastro-enterostomy	87	*	1.1	0.0
Excision	84	57	4.7	32.0
Sleeve resection	12	90	...	....
Anterior gastro-enterostomy	27	72	3.7	3.8
Pyloroplasty	26	75	7.0	15.0

*So little time has elapsed since this operation was instituted that a statement regarding the present condition of the patients would be of no real value.

Table IX is a recapitulation of the results of the various operations for gastric ulcer, with the operative mortality and the percentage of the patients so operated on who returned for secondary operations.

Table X is an abstracted compilation of these secondary operations.

There are certain facts in the tables which appear to justify emphasis.

1. For ulcers at the pylorus, posterior gastro-enterostomy is the operation of choice in the poor surgical risk, for although pylorectomy is followed by better results, the operative mortality is distinctly higher. The cautery is a useful adjunct in selected cases.

2. For ulcers on the lesser curvature, cautery by the method described in a previous paper (7), and gastro-enterostomy is the operation of choice.

TABLE X. REPORT ON SECONDARY OPERATIONS ON GASTRIC ULCERS (47 CASES, 6.8 PER CENT OF 670)

(From January 1, 1906 to November 1, 1916)

Original Operation	Time since First Operation	Cause for Second Operation	Second Operation
Excision, 27 cases	1–1.5 years, 7 cases 2–2.5 years, 5 cases 3–3.5 years, 5 cases 4 years, 1 case 4–10 months, 4 cases 1–2 weeks, 3 cases 10–18 days, 2 cases	Obstruction, 10; ulcer bleeding, 3; ulcer, 3; hour-glass, distention, 2; adhesions, 1; subacute perforation, 1	Posterior gastro-enterostomy, 25; anterior gastro-enterostomy, 1. Adhesions were freed in 2 of the above cases. An old scar excised and a transfusion in another.
Excision and posterior gastro-enterostomy, 2 cases	2 months, 1 case 6 days, 1 case	Obstruction from kinked pylorus, 1. Obstruction and abscess, 1	Anterior gastro-enterostomy, 1; drainage of abscess, jejunostomy and transfusion, 1.
Excision and pyloroplasty, 4 cases	2 years, 2 cases 1 year, 1 case 1 month, 1 case	Ulcer, 2 Abscess, 1	Cautery and posterior gastro-enterostomy, 1; excision and gastro-enterostomy, 1; posterior gastro-enterostomy, 1; drainage of abscess, 1.
Pylorectomy, 3 cases	6 years, 1 case 3 years, 1 case 5 days, 1 case	Jejunal ulcer, 1 Carcinoma of stomach, 1 Acute obstruction and dilatation, 1	Anterior gastro-enterostomy (Murphy button), 1; transverse colon resection and resection of jejunum and jejunostomy 10 days later, 1; exploration, 1.
Anterior gastro-enterostomy, 1 case	1 week, 1 case	Bile regurgitation, 1	Entero-anastomosis (Murphy button), 1.
Posterior gastro-enterostomy, 4 cases	3 years, 1 case 1 year, 1 case 2 weeks, 1 case 10 days, 1 case	Ulcer, 3; ulcer causing hour-glass, 1	Freeing adhesions, 1; enlargement of gastro-enterostomy, 1; excision of ulcer, 1; resection of pylorus, 1.
Gastrogastrostomy, 4 cases	3 years, 1 case 2 years, 1 case 1 year, 1 case 1 month, 1 case	Hour-glass, 1; adhesions, 1; bleeding ulcer and adhesions, 1; obstruction, 1	Posterior gastro-enterostomy, 2; anterior gastro-enterostomy, 1; anterior retrocolic gastro-enterostomy and splenectomy, 1.
Incision and drainage, 1 case	2 years, 1 case	Pyloric obstruction, 1	Posterior gastro-enterostomy, 1.
Reinforcement, 1 case	3 years, 1 case	Ulcer, 1	Posterior gastro-enterostomy, 1.

3. Local excision alone of such ulcers is inadequate, 32 per cent of patients so operated on ultimately requiring further operative treatment, viz., gastro-enterostomy.

4. Sleeve or segmental resection, especially in large high ulcers and hour-glass contraction in suitable cases is not only a relatively safe operation but has been followed by good results.

5. The lowest operative mortality in the more common operations was associated with cautery and posterior gastro-enterostomy.

6. Ulcers on the posterior wall are associated with the highest operative risk, while those at the pylorus are of least risk.

REFERENCES

1. BREWER, G. E. A critical review of a recent series of operations upon the stomach. Ann. Surg., Phila., 1907, xlv, 687–698.
2. WOOLSEY, G. The surgical treatment of gastric and duodenal ulcers. Med. Rec., 1916, lxxxix, 592–596.
3. SCUDDER, C. L., and HARVEY, S. C. Is the employment of actual cautery in the treatment of chronic ulcer of the stomach a safe procedure? Surg., Gynec. & Obst., 1916, xxiii, 719–724.
4. PAUCHET, V. Traitement de l'ulcere chronique de l'estomac. Presse méd., 1916, xxiv, 445–448.
5. HAINES, W. D. Personal communication.
6. STEWART, C. D., and BARBER, W. H. Segmental resection for gastric ulcer: a preliminary report based upon clinical and experimental studies. Ann. Surg., Phila., 1916, lxiv, 527–536.
7. BALFOUR, D. C. The treatment by cautery of gastric ulcer. Surg., Gynec. & Obst., 1914, xix, 528–530.

DEPARTMENT OF TECHNIQUE

GENERAL RULES USED IN SIMPLE PLASTIC WORK ON AUSTRIAN WAR-WOUNDED SOLDIERS

By Dr. J. F. S. ESSER, Arnhem, Hollone
Dutch Special Surgeon for Plastics

FOR eight months in 1915, I was chief surgeon of the Royal Reserve Hospital No. 2 in Bruenn, Moravia, with more than 3,000 beds. Here I did more than 400 plastic operations. The cases were sent to me from all Moravia by military command of the late chief army surgeon, Dr. Schwarz, and later on by a further order from his Excellency, Lieutenant Field Marshal Poeschmann, through whose order I could select such cases in every hospital there.

Because of my success in these cases as well as in the cases operated on afterward in the Royal Reserve Hospitals Nos. 8 and 17, and in the university clinic of Professor von Hochenegg in Vienna, I shall describe some principles in technique which I particularly recommend. I shall not mention here the complicated face plastics, those with free transplantation, and those with application of pedicle flaps from distant parts of the body, nor shall I describe æsthetic operations or plastics on the skull and other parts of the body.

As a rule I make my technique in plastic operations as simple as possible. I prefer to cover defects of the face with tissue from the immediate neighborhood, contrary to the general rule as shown in the works of nearly all plastic surgeons. I avoid, when possible, the application of pedicle flaps from a distance. I follow this principle not only because the technique is simpler, but chiefly for æsthetic reasons.

The result in most facial plastics would seem to indicate that the surgeon is chiefly concerned in seeking the easiest and surest way to success without considering that intervention must also, in nearly every patient, satisfy his sense of beauty.

It is certain that not every surgeon, however distinguished, is qualified to do facial plastics, and this is especially true if he does not appreciate the æsthetic and has not a thorough understanding of all the requirements. He must be blessed with the rich gift of invention, and must possess as well mathematical and economical knowledge. I will only mention the great responsibility as far as the patient is concerned. He concentrates all his hopes on attaining a beautiful result. Even after very exhausting operations consuming 4 or 5 hours, performed without an anæsthetic, the first request the patient makes is almost always for a mirror. With the smallest imperfection, especially as regards hair, it is striking to find that even the rudest peasant continually begs for correction.

I combine all facial plastics, therefore, because the first consideration is the good appearance of the patient. This requisite distinguishes plastic operations from all other operations which have for their object a practical result.

Æsthetics play an important rôle in facial plastics. Every one who has had occasion to converse with mutilated patients knows how great deformities influence their composure, however much they try to conceal their embarrassment. It is not sufficient merely to close facial defects, however perfect the result may be from a surgical standpoint; the operation must be done so as to insure the patient not only a perfect result surgically but his face must be restored as nearly as possible to its normal appearance.

In the first place, the foundation for the plastic must be suitable. A potato-like formation, with two outward openings, is not a nose, however well healed and vascularized it may be. The muscles of expression must be considered, fat tissue must be provided, and lastly the skin to be used must be chosen so that it closely resembles the skin in the area to be covered, in color, shade, elasticity, hair, thickness, fiber-direction, number and size of the pores; in short, in all its qualities.

We very often see patients, who have been dismissed after a plastic as recovered, in whom only the defect has been closed, and the modeling not yet done. I maintain that a soldier who has done his duty and has risked his life fighting for his Fatherland, has the right, when he is mutilated, to demand from the same Fatherland that it do all in its power to restore him to

normal. I mention this, for however reasonable it may seem, many surgeons do not agree with me.

The social side of life must be given due consideration in deciding on the indications for plastic operation. The patient who returns to society after an excellent operation feels happy and as newborn. Those who have suffered mutilating injuries to the face, have the greatest desire to be operated upon as soon as possible. Thus, it is seen that plastic operations upon the face are in many ways as important as are the more common operations; for while they may not save the patient's life, they do help to alleviate pain and to free the patient from many distressing conditions such as the inability to eat, breathe, or speak properly as well as the inability to retain saliva.

In doing these operations, the entire face must be considered, because operations for the correction of one part must not mutilate another part, and when the defects interlap, especial care must be exercised.

The most essential principle in all plastic operations is simplicity. Simplicity facilitates the work and preserves the beauty. The use of skin from a nearby surface is therefore to be preferred to skin from distant parts. In almost every instance, even in very large defects, this principle of technique can be carried out. The one point necessary is that the parts be made sufficiently movable, either by cutting on one side (half pedicled), or, when necessary, with entire pedicles. When this is not possible, I use a pedicle flap from a distant part, or a free transplant. The general opinion that this local treatment causes deformities is false. The result depends on the technique.

However plausible it may seem to use neighboring tissue, most plastics have been treated otherwise. The careful use of the above-mentioned principles often forces one to enter new paths and work independently, as many existing operations for certain defects are contrary to this rule of simplicity. This axiom applies to small defects, for which when possible, I apply the simple lineal seam in cases where many other surgeons use pedicle flaps and free transplants. Some of my cases will show this. I would only say that I take much trouble to make every seam as nearly perfect as possible. By this care in details, love for even the smallest work is awakened and the success of the plastic operations increased and brought nearer to the ideal.

For control, I always have the interesting cases photographed from three sides, both before and after operation. Care is taken to get all the photographs equally sharp and no retouching is done. Some of my photographs from Bruenn are not good because my photographer had to go to the front.

When the wound edges fell in, I undercut the fat and muscle tissue and by layers of sutures, brought them together in a ridge exactly beneath the suture line. It is of great importance that this ridge of fat and muscle follow exactly the suture line so as to raise the wound edge to the level of or a little higher than the surrounding part (Figs. F to I).

As mentioned above, the æsthetic advantage of using skin bordering on the defect, is that it corresponds better in quality, color, shade, elasticity, hair, thickness, fiber-direction, number and size of pores, than is the case with pedicle flaps from forehead, temple, or neck, not to speak of the skin of the chest or arm.

The fear of many surgeons of extropion and partial immobility after lineal sewing of facial defects, is groundless in carefully chosen cases and with good technique. This fear has stood in the way of the finer development of the technique governing their dangers.

However imposing the genial work of Lexer on free transplant is, it should not lead to a general usage of the same. They may be used only when a pedicle flap is impossible.

Before entering into details of the different groups, I wish to mention a few general principles. Above all, I lay the greatest weight on strict asepsis. One often hears from experienced surgeons that much may be tolerated in the neighborhood of the mouth and nose, because these tissues through their rich blood and lymph supply more easily resist bacteria. In their opinion so much impurity, which cannot be removed, is always present, that one need not be so careful about the asepsis. This is not the case, for two reasons. First, while these tissues can defeat many infectious germs, they are resistant only against those belonging to that region. Therefore, one must avoid introducing foreign bacteria here just as one does in pure tuberculous abscesses. Because of the great richness in blood and lymph vessels, the fight between bacteria and tissue is usually decided rapidly in favor of the individual; but during this short time a greater danger of general infection exists or for spreading of infection (meningitis) than in tissue with few vessels. Secondly, a disadvantage of non-aseptic procedure is the less beautiful healing. Only wounds which heal by first intention, can, when all other circumstances are favorable, give good results.

Before the operation the skin is shaved, using no moisture, and then painted with tincture of

For full description of plates see case reports.

Figs. 1 and 2. Case 1. Gunshot wound of chin. Fig. 2. Result after plastic.

Figs. 3 and 4. Case 2. Fig. 4 shows a scar scarcely visible due to the fact that the pressure is borne by deep sutures.

Figs. 5 and 6. Case 3. Gunshot wound of upper eyelid.

Figs. 7 and 8. Case 4. Gunshot wound of the ear.

Figs. 9, 10, and 11. Case 5. Shot through under lip. The red of the lip was reconstructed with great care, one of the most difficult tasks in plastic surgery. The result was very satisfactory.

iodine. During the operation the skin is kept as dry as possible.

I use local or regional anæsthesia for all face plastics. As small quantities as possible of anæsthetic solutions are used, because I believe that the tissues are not indifferent to, and that their defensive powers are reduced by even a weak solution of, novocaine, and adrenalin. For the same reason, I do not infiltrate far around the wound, but into the same, so that most of the fluid injected escapes during the operation.

Further, the greatest care is used in the total excision of all superficial and deep scars. This is conducive to a more beautiful form, and also when the muscles are sewn carefully together, to a restoration of the power of expression. Besides later shrinking of the scars is avoided. Even in rather large defects with lineal seam, I allow no tension in the skin itself. All tension is borne by the deep hidden sutures. I seldom use very large deep sutures from the surface on metal plates, as Lindemann does, because pressure necrosis frequently occurs beneath the plates, leaving ugly scars. For diminishing new defects, this method is excellent.

Upon finishing the operation, some calomel is blown from a pulverizer on and around the wound, which is then left uncovered when there is no special reason for bandaging. The advantages of the uncovered wound are many, especially in

Figs. 12 to 14. Case 6. Jaw-cheek injury.
Figs. 15 to 17. Defect of upper lip. Fig. 16 shows the prominence of the upper lip after repair.

the presence of mouth, nose, and eye secretions. The skin does not macerate but remains dry so that the growth of bacteria and their inoculation of the wound does not occur. Light, and especially sunlight, having access to the wound, acts as a disinfectant of, and as a stimulant to, the tissues.

For the past two years, I have powdered the wounds with calomel, and am very well satisfied with it; first, it dries the wound and is then diffused into the very small scab. Traces of the sublimate are formed constantly from the calomel. In a nascent state, these are very bactericidal. I have never observed a deleterious effect from the use of calomel, which is reasonable since even the conjunctival sac tolerates its presence.

That sick rooms may not be dusted is obvious, but must instead be cleaned with a damp cloth.

The dry wound edges do not so easily permit gaps in places where there is a slight difference of tension, as a loose soft skin would under a bandage. They either unite smoothly throughout or gape entirely (which accident does not often occur).

The uncovered wounds permit of regular and frequent inspection, and when necessary removal of one or more stitches. The stitches always lie very close to each other, and enter not toward the wound edge, but perpendicularly or receding further from the edge (Figs. A and B). Stitches are never put in exactly at the wound edge because then the knots are easily drawn into the cut, causing unsightly and uncertain results.

I lay great weight on the absolute immobilization of the wound, which principle is acknowledged everywhere at the present time. I forbid the patients to speak or to move their lips. I usually order only liquid diet which is given through a rubber tube. So necessary do I re-

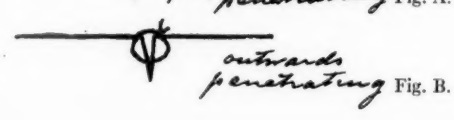


Fig. A.

Fig. B.

gard immobilization, that for a few days in many cases, I forbid the very important rinsing of the mouth, even after operations which involve the inside of the mouth. Sometimes in these cases I allow the nurse to syringe the mouth with the greatest care. Thin soups are preferred rather than milk, because they do not leave so much impurity.

I divide simple face plastics into the following groups, of which I shall discuss typical cases:

1. Simple lineal seam:
   - *a.* After scar excision.
   - *b.* After scar and skin excision.
2. Complicated lineal seam:
   - *a.* With underlay from direct neighborhood.
   - *b.* With underlay of free transplanted fat.
   - *c.* With alteration of skeleton.
3. Seam with displacement of one wound flap after mobilizing it by simple cut:
   - *a.* With very large basis.
   - *b.* With narrow pedicle.
   - *c.* With island-flap
4. Seam after mobilization of both flaps.

1, *a.* SIMPLE LINEAL SEAM AFTER SCAR EXCISION

I will present many cases of this group in order to show how a very considerable number of different deformities, which are often treated with rather complicated plastics, can be helped in a most simple manner.

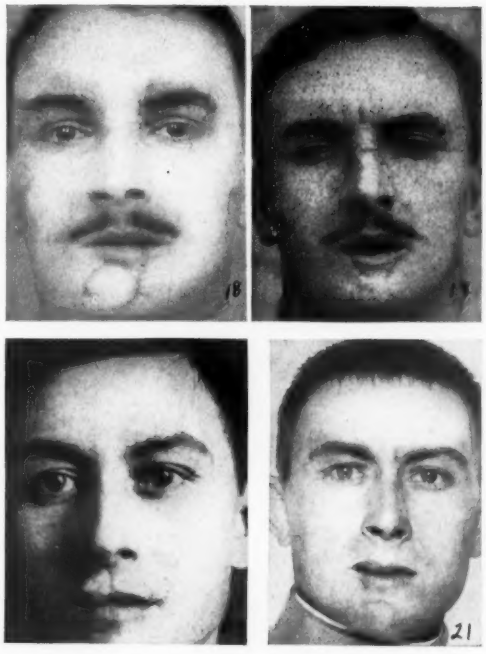
CASE 1. Lieutenant R., Vereins Reserve Hospital No. 1 in Bruenn (Figs. 1 and 2), had a gunshot of the chin which healed with many scars, after the excision of which, the surroundings were simply sewn together.

CASE 2. Infantryman M., Royal Reserve Hospital No. 8 in Vienna (Figs. 3 and 4), came under my treatment for a gunshot of the jaw which I repaired with a local bone plastic. The protruding nail in the chin perforated the entire right lower jaw to fix the fragments and transplant. I present him here only to show that it was possible to take the large angioma from the forehead, the defect of which was simply sewn together after mobilizing the wound edges. Figure 4 shows that a seam even under great tension can be sewn together leaving a scarcely visible scar, when great care is taken that the pressure is borne by the deep sutures.

CASE 3. Infantryman S., Royal Reserve Hospital No. 2, Bruenn. A defect of the upper eyelid from gunshot wound (Figs. 5 and 6) was closed with a lineal seam after freeing the wound edges. The scar is scarcely visible.

CASE 4. Infantryman Im. N. of above hospital, sustained gunshot wound at the ear (Figs. 7 and 8). After excision of the scar, the wound edges were correctly placed opposite each other and sewn together. The result was, as shown, very beautiful.

CASE 5. Infantryman S. of Royal Reserve Hospital No. 17, Vienna (Central hospital for jaw injuries). Shot though the under lip and jaw. Wound healed with deep lip and jaw scar with loss of movement (Figs. 9, 10 and 11). Complete excision of the scar and all its branches was done. The red of the lip was reconstructed with great care. This belongs to one of the most difficult tasks in plastics, if a good cosmetic result is to be obtained. The deep sutures bring the skin and mucous membrane together, so that they are approximated without tension.



Figs. 18 and 19. Case 8. Penetrating gunshot wound of the lower lip.
Figs. 20 and 21. Case 9. Upper lip injury.

CASE 6. Soldier S., Vereins Reserve Hospital No. 1, Bruenn. Jaw-cheek injury. After a long healing process, complicated by erysipelas, with ejection of many important jaw fragments, the deep wound had finally decreased considerably and was firmly scarred (Figs. 12 to 14). After excision of the extensive scars, the sewing of the muscles was carefully done, and with it an underlay was formed for the sewing of the skin which followed.

CASE 7. Infantryman Z., Royal Reserve Hospital No. 2, Bruenn. Defect of the upper lip (Figs. 15 to 17). This case was similar to Case 3 in reference to the deep sutures in mobilized tissue, which bring together the superficial wound-edges and at the same time raise them to the right level. Figure 16 shows that the repaired upper lip

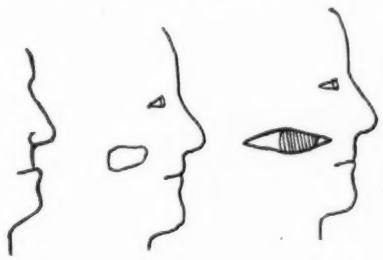


Fig. C. Fig. D. Fig. E.

Figs. 22 and 23. Case 10. Upper eyelid gunshot defect.
Figs. 24 and 25. Case 11. Gunshot wound of cheek and nose.

Figs. 26 and 27. Case 12. Injury to lower half of right ear and part of cheek.
Figs. 28 to 31. Case 13. Correction of scar of skull after trepanning and scar after injury to lower jaw.

has become sufficiently prominent by this method and that it has not fallen back, as is so often the case in repaired harelips, which are usually recognizable as such from afar. Annexed illustration Fig. C, shows this condition in a badly treated harelip.

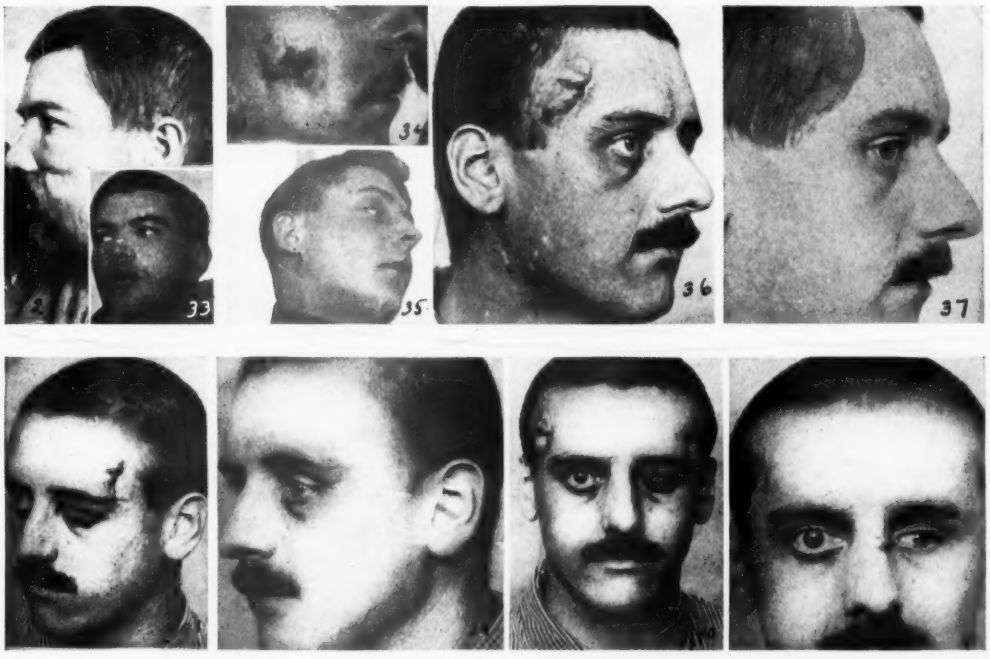
CASE 8. Infantryman P., Royal Reserve Hospital No. 8 in Vienna, had penetrating lower lip under jaw gunshot resulting in a pseudarthrosis and a soft part scar. The latter entirely surrounded the chin. Was removed by excision and repaired by lineal seam in stages (Figs. 18 and 19).

CASE 9. Soldier D., Royal Reserve Hospital No. 17 in Vienna, suffered a vertical split of the upper lip from a gunshot wound which after this repair healed, leaving no visible sign (Figs. 20 and 21).

CASE 10. The same with Infantryman P. S., Royal Reserve Hospital No. 2 in Bruenn, who had an upper eyelid gunshot defect which was improved by excision of broad parts and making a smaller eyelid (Figs. 22 and 23).

1, *b*. SIMPLE LINEAL SEAM AFTER SCAR AND SKIN EXCISION

CASE 11. Infantryman Z., Royal Reserve Hospital No. 2 in Bruenn. Gunshot wounds of cheek and nose resulted in two scars which were both cut out (Figs. D and



Figs. 32 and 33. Case 14. Shot through cheek and adjoining nostril. Fig. 33 shows the final result.

Figs. 34 to 41. Cases 15 and 16. Correction of deep broad cheek scar (figs. 34 and 35) and deep fixed temple scar (Figs. 36 to 41).

E). Because the cheek wound was too nearly round, it was lengthened by excision of normal cheek skin. A large piece of adjacent subcutaneous tissue was removed to imitate there the condition of the original wound, the scars of which had been excised. The entire wound was then closed with equal tension (Figs. 24 and 25). In this case, I had to be careful on account of the Stensen's duct and facial nerve. The scar on the nose was repaired by a small pedicle flap (Figs. 24 and 25).

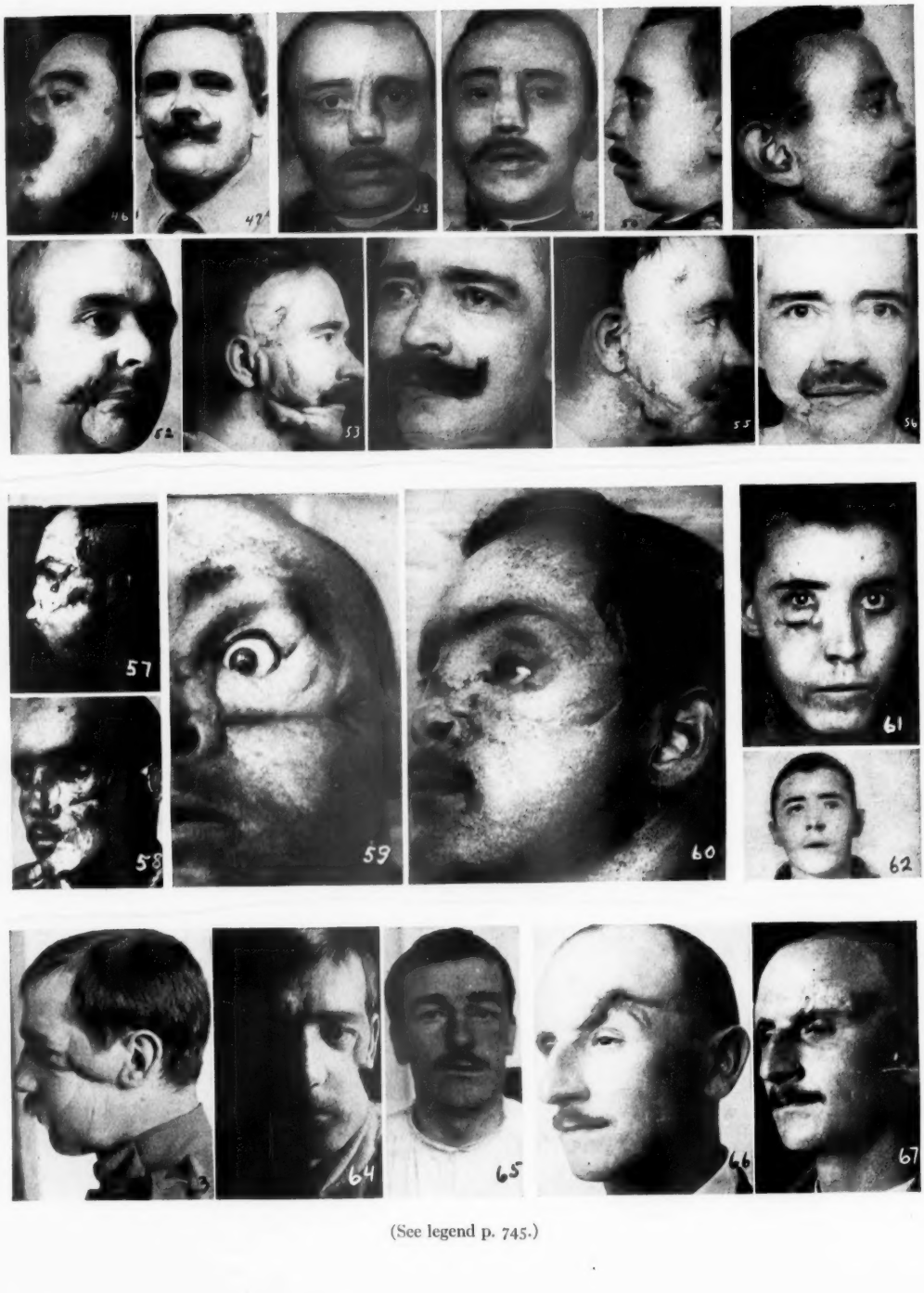
CASE 12. Infantryman S. V. of the same hospital (Figs. 26 and 27) had the lower half of his right ear and a part of the cheek shot away. The cheek defect was closed by lineal seam, after the excision of healthy skin, as in case above which then gave good conditions for repair.

CASE 13. Similar procedure was followed in the case of infantryman Fr. (the same hospital) to correct a scar fixed on the skull after trepanning. A soft part scar fixed on the lower jaw, from another shot, was also improved. On the forehead the closing of the bone defect was made with a pedicled bone flap (Figs. 28 to 31).

2, *a*. COMPLICATED LINEAL SEAM WITH UNDERLAY FROM DIRECT NEIGHBORHOOD

CASE 14. Infantryman J. P., Vereins Reserve Hospital No. 1 in Bruenn, was shot through the cheek and adjoining nostril (Figs. 32 and 33). I prepared the plastic for this by

Figs. 42 to 45. Cases 17 and 18. Correction of deep fixed scars on cheek.



(See legend p. 745.)

(Figs. 46 to 67 see p. 744.)

Figs. 46 and 47. Gunshot wound of jaw. Skin scar corrected.

Figs. 48 to 51. Different stages in the correction of nose deformity.

Figs. 52 to 56. Correction of fixed scar at corner of mouth.

Fig. 57 to 60. Mutilating face injury.

Figs. 61 and 62. Case 23. Upper cheek wound.

Figs. 63 to 67. Cases 24 and 25. Corrected with underlay of free transplants of fat.

Figs. 68 and 69. Case 26. Lower eyelid and nose defect.

Figs. 70 and 71. Case 27. Eyelid mutilation. Fig. 71 shows the condition before an attempt to smooth the flap scar.

Figs. 72 to 74. Case 28. Upper lip defect. Result seen in Fig. 74.

cutting laterally on both sides into the deep tissue and then by sewing the mobilized subcutaneous tissue together to raise up to a good level the skin suture line which then followed (see Figs. F to I). Figure 33 shows the final result.

CASES 15 and 16. I did a similar operation on Infantryman N. (in the same hospital) for a deep, broad cheek scar; and on Infantryman V. (in Royal Reserve Hospital No. 8 in Vienna) for a deep fixed temple scar, which followed trepanning (Figs. 34 to 41).

CASES 17 and 18. Infantrymen S. and K., Vereins Reserve Hospital No. 1 in Bruenn. Both had deep fixed scars on the cheek, which were removed in similar way (Figs. 42 to 45).

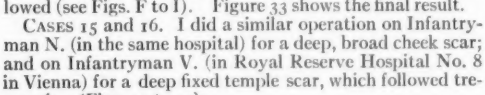


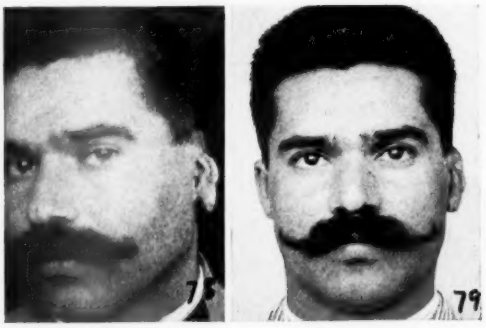
Fig. F. Fig. G. Fig. H. Fig. I.

CASE 19. Infantryman P., Reserve Hospital No. 17 in Vienna, following a gunshot wound of the jaw had a defect in which the skin scar was corrected (Figs. 46 and 47).

CASES 20, 21, and 22. are three patients who were operated upon by very distinguished surgeons. Their wounds healed perfectly from a surgical point of view, but the patients were not socially presentable, so that I received them for corrections.

Sergeant A. in peace time had an injection of paraffin in his sunken nose bridge. In the winter of 1915 on the Carpathian front, the skin covering the paraffin froze and necrosed. The defect was closed at that time with a pedicle flap from the forehead. The flap, however, was so prominent that the patient had a wax shell made to cover the nose. The correction which I made was merely to cut out the scar on one side and to diminish the soft tissue on that side of the flap by placing it partly under the opposing skin edge before suturing. After ten days I repeated this operation on the opposite side (Figs. 48 to 51).

Figs. 75 and 76. Case 29. Loss of under part of upper lip.



Figs. 78 and 79. Case 30. Loss of upper lobe of ear. Correction gave very satisfactory result.

Captain T. An injury to the mouth healed with a fixed scar at the corner. This was cut out and replaced by a temple pedicle flap (Lexer). The patient, however, had deformities which obliged him always to wear a black covering over the entire cheek. In a manner similar to that used in the case above, I leveled the surface in the clinic of Hochenegg (Figs. 52 to 56).

Infantryman V., Vereins Reserve Hospital No. 1, (Figs. 57 to 60) received a very mutilating face injury which took away his left eye, lower eyelid, and disfigured his cheek and nose. After a Lexer temple flap plastic, the patient was sent to me. I do not mention here the corrections I made on the temple defect, the nose (which is not yet quite finished) and the eyelid plastics; but only show the correction on his cheek which I did as in the two cases above.

Case 23. This Russian after an upper cheek wound, had a large scar, which I removed. The defect was closed in the manner described above (Figs. 61 and 62).

2 *b*. COMPLICATED LINEAL SEAM WITH UNDERLAY OF FREE TRANSPLANTED FAT.

Cases 24 and 25. Infantrymen U. (Figs. 63 to 65) and D. (Figs. 66 and 67), both in Royal Reserve Hospital No. 2 in Bruenn, are both types of a series of cases in which an underlay from the immediate vicinity did not suffice; therefore free transplantation of fat from the abdominal wall or buttock was done. In the case of D. it should be mentioned that I took a two inch pedicled curved bone chip from the medial side of the defect, working in part subcutaneously. After turning this bone, it bridged over the bony defect and was fixed at its end. In this manner a new bone arch was constructed, which was covered by the transported fat. Shortly after the stitches had been removed, D. was photographed, because he had to go away. The scars were much smoothed some weeks later when I saw him.

The disadvantages of this method are twofold: first, the chances of the free transplant to live are good but not so sure, especially in presence of scars, and where latent infection centers exist. Second, due to the shrinking of the fat, the underlay changes size and form, so that originally it must be too large. After shrinkage it fits, but then gradually it may become too small. Individual and local differences also add to the uncertainty of the amount of fat to transplant, so that in any case, the quantity is very difficult to estimate.

2 *c*. COMPLICATED LINEAL SEAM WITH ALTERATION OF SKELETON

In this group only appear patients with nose defects. I took away scars and part of the nose skeleton, which could be dispensed with, in order to be able to close the defect with the healthy nose skin that was left without adding flaps from other places. These cases are published separately, combined with some æsthetic nose corrections of peace-time cases.

3 *a* DISPLACEMENT OF ONE WOUND FLAP, AFTER MOBILIZING IT BY SIMPLE CUT WITH VERY LARGE BASE

Gradually we come to larger plastics with defects of broader areas of the cheek, upper and lower lip, in which I took material from the neighborhood and not from distant parts, such as pedicle flaps of arm or chest. These flaps are disagreeable for the patients and do not give good cosmetic results. For the larger defects, I made an incision subcutaneously which mobilized the whole cheek and the skin of the upper lateral neck, by cutting around from the defect in a broken curve, first rising, then turning downward in front of the auricle, then horizontally and ending with a sudden vertical cut to make the whole movable. The pedicle of this flap carries the external maxillary artery. I will not enter into further details of this type of operation now, as the subject is so large as to require special treatment. In cases of smaller defects in the upper cheek, I work as the following cases show:

Case 26. Infantryman Z., Royal Reserve Hospital No. 2 in Bruenn, later No. 8 in Vienna (Figs. 68 and 69).

Figs. 80 to 82. Case 31. Gunshot injury of jaw.
Figs. 83 and 84. Case 84. Gunshot injury of jaw.
Figs. 85 to 87. Case 33. Mutilating injury of chin.
Fig. 88 to 91. Loss of entire nose except bony skeleton.

lost his right eye, and received a lower eyelid and nose defect. I will show here only the lower eyelid treatment. The right side of the wound, which contained the greater part of the lid, was mobilized to form the new lid (see Figs. J and K). The new small eyelid was stretched by gradually increasing the size of the artificial eye.

Case 27. Infantryman M., Royal Reserve Hospital No. 8 in Vienna (Figs. 70 and 71), had a similar eyelid mutilation and an artificial eye could not be introduced. He came to me after having been unsuccessfully operated upon. The new plastic was made in a manner similar to that in the preceding case. Figure 71 shows the condition before an attempt to smooth the flap scar. The patient has closed his healthy eye.

3 b. DISPLACEMENT OF ONE WOUND FLAP AFTER MOBILIZING IT BY SIMPLE CUT WITH NARROW PEDICLE.

In the case of Infantryman S. (Figs. 72 to 74) in above hospital, a small very hairy pedicle flap (pedicle at top) was placed after scar excision in the under lateral part of the left lip defect, which was raised. This was taken with pedicle at angle of mouth. Secondary defect was sewn together. Later, a pedicle flap from the middle of the under lip was placed in the upper lip (Lexer). Figure 74 shows result.

Case 29. The patient, Infantryman J., Royal Reserve Hospital No. 8 in Vienna (Figs. 75 and 76) had lost the under part of left upper lip, and in addition he had deep scars upward and laterally in the cheek. After excision of of all scars, a large pedicled flap of the orbicularis oris with mucous membrane from the underlip was used. The functional as well as the æsthetic result was very satisfactory.

Case 30. Infantryman S., same hospital (Figs. 78 and 79), had lost the upper half of the ear and half of the lobe. After spreading out all the skin of the remaining auricle on its anterior surface, the back wound was covered with a pedicle flap from the neck. The ear looked almost normal afterward. The secondary defect was sutured. For the upper auricle defect, the entire hairless skin behind the ear

was used with a pedicle at the top. The flap doubled over. The secondary defect was closed with a free transplant from the arm, using the Krause method. After union occurred, a piece of cartilage was taken from the now too large opposite ear and used to model the new ear. When finished the patient was shown in the Society of Surgeons in Vienna.

3 *c*. SEAM WITH DISPLACEMENT OF ONE WOUND FLAP AFTER MOBILIZING IT BY SIMPLE CUT WITH AN ISLAND-FLAP

In many cases I used skin flaps which had no skin pedicle for covering defects, especially near the angle of the mouth. These flaps had a subcutaneous pedicle, including the external maxillary artery. These flaps have many particular advantages respecting the nourishment, beauty and practicability. The patients of this kind are to be separately described.

4. SEAM AFTER MOBILIZATION FO BOTH FLAPS

The frequent appearance in war of total or partial lower lip defects with or without jaw injuries, gave me a great number of similar cases, of which I shall mention only a few examples. In all these cases, I was able to make the repair with tissue from the neighborhood, often by mobilizing the flaps by large curved cuts. The scars were always entirely removed. The tension was divided over the largest possible surface, which often included large areas on the neck. The formation of a new mouth was always a difficult task because of the necessity of getting well formed and movable lips. The new orbicularis oris was always first constructed, even though the mouth became very small. The mouth was then enlarged later by stretching apparatus or operation. Unequal upper and underlips were often equalized by the methods of Lexer or Estlaender, i.e., from the middle or from the side.

CASE 31. A Russian prisoner of war in Vereins Reserve Hospital No. 1 in Bruenn, came to me with gunshot jaw injury after an unsuccessful plastic (Figs. 80 to 82). After an exact excision of all the numerous branched scars, the whole skin of the chin and the remains of the lips were mobilized by curved cuts. All were then sutured (Figs. L. and M.). Similar to Morgan's method, I drove an ordinary carpenter's nail into the jaw, after having previously bored through the outer table. This was for the purpose of holding the skin up over the chin. However my nail was driven much deeper and with point directed more downward.

CASE 32. A quite similar proceeding occurred with the soldier L. of Royal Reserve Hospital No. 17 in Vienna (Figs. 83 and 84).

CASE 33. Infantryman P. V. (Figs. 85 to 87). I had the honor, as a guest, of operating on him in the clinic of von Hochenegg. The lower lip was formed by mobilizing the right and left sides of the defect together with the left end of the upper lip (See Figs. N and O). It should be mentioned that a large pedicle flap from the scarred skin over the chin was used as substitute for mucous membrane, because this skin on account of its ugly scars could not be used facing outward. In the mouth cavity, a long curved incision was made in the right fornix as deep as possible, and ending suddenly with a vertical one inch cut, to mobilize the right flap. The healing of all the flaps was complete except for a fistula, which formed at the site of the former left cheek scars, which had been removed. This fistula soon disappeared spontaneously. In order to avoid complicating the description, I shall not mention now some corrections which followed.

CASE 34. Infantryman J. T., Royal Reserve Hospital No. 8 in Vienna (Figs. 88 to 91), lost his entire nose as the result of an explosion of grenade shot. Only the skeleton of the nose remained, covered by a small amount of scarred skin. Both upper jaws were fractured, the left quite shattered. The upper lip and processus alveolaris were badly injured. I shall mention here only that I got sufficient skin for the nose by mobilizing the cheek skin subcutaneously on both sides. This was done by working through the mouth without cutting the skin. This mobilized skin was first spanned over two metal arches, which had been previously prepared. These ended in points which rested on the upper jaw. In one week these arches were removed from the nostrils after cutting them in two.. The nose skin was then supported with gauze pads until the new bony skeleton took up this function. The nostrils were formed from pedicle flaps of the naso-labial-fold. The upper lip has still to be enlarged from the lower lip by Lexer's method, with this modification, that the new skin septum of the nose will be formed from the skin over the chin. This also facilitates closing the secondary defect. Figure 91 shows the patient with a skin protuberance, resembling a horn on the chin. This is made to be followed by the Lexer operation, in which case this horn is turned upward in connection with the flap to form the skin septum of the nose rising from the upper lip.

FREE MUSCLE–TENDON–BONE TRANSPLANTATION FOR OLD FRACTURE OF THE PATELLA

By WALTER M. BRICKNER, M.D., F.A.C.S., New York
Associate Surgeon, Mt. Sinai Hospital

A S., a farmer of 57, in good health, was referred to me on July 15, 1916, by Dr. Herman Schwartz, with a transverse fracture of the right patella, which he had sustained more than a year before, and for which he had had no treatment whatever.

The quadriceps was very much atrophied and contracted and the patellar fragments, of equal size, were widely separated. I thought, however, that under narcosis, and with the assistance of liberating incisions in the muscles, I would be able to secure approximation.

At *operation* (July 17, Park Hospital, ether) I found that traction on the exposed upper fragment of the patella brought it down but very little indeed. Vertical incisions were then made through the muscles on each side of the rectus femoris, in the lines *AB* and *CD* (Fig. 1). But even when these had been gradually extended the full length of the quadriceps bursa and a little beyond, the upper fragment could be moved down but little more than before: the separation was still about an inch.

A transverse incision (*EF*) was made partly across, and through the thickness of, the restraining rectus femoris tendon. Traction then made the bone approximation a little closer but still very insufficient.

At this stage there seemed nothing to do but to complete the transverse incision *EF* by extending it on each side to meet *B* and *D*. This incision cut the mass *ABDC* from all attachments and, indeed, *I lifted the upper half of the patella and the attached tendon-muscle mass away from the patient's body!*

The freed upper half of patella was then laid in contact with the lower half, after freshening the edge of each; and the fragments were united with two kangaroo tendon sutures passed through drill holes. The periosteum and the torn joint capsule were stitched with chromicized catgut; and the transplanted muscle-tendon mass was sutured in its new bed with kangaroo tendon and chromicized catgut, as illustrated in Figure 2. The skin wound (Fig. 3) was closed without drainage; and a plaster-of-Paris cast was applied in full extension. Lane technique was employed throughout the operation.

The postoperative course was afebrile and on the twelfth day the skin wound was found healed *per primam*. On August 5, the patient was discharged from the hospital, the leg still in extension in the split plaster cast.

Six weeks after operation the patella was solidly healed. Although the transplanted tendon-muscle mass had shrunken somewhat in bulk, it had not undergone absorption and no separation was palpable in the lines of muscle suture. The quadriceps was, however, more atrophied than before operation, and *it showed at no place any response whatever to galvanic or faradic stimulation!* In spite of the bony union, therefore, the chance of a functional cure appeared to be very small indeed. At that time there was also noted a decided drop-foot, which had probably developed from nerve pressure by the cast.

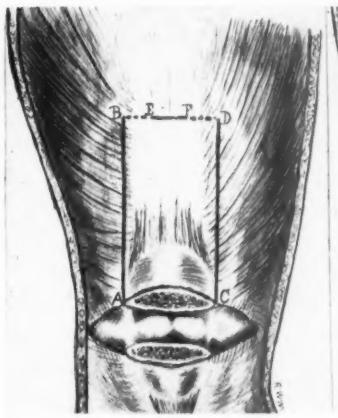


Fig. 1.

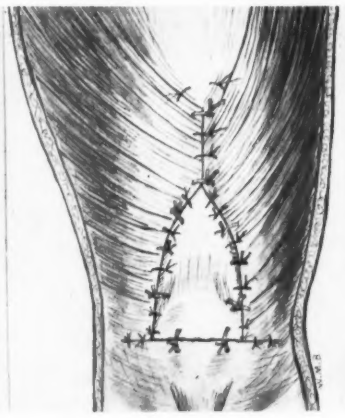


Fig. 2.

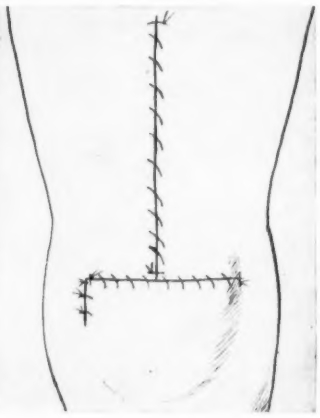


Fig. 3.

Fig. 4.

Fig. 5.

The patient was then put in the hands of an experienced and very competent masseur, Mr. Karl Steiner, who had the man under constant supervision in his home, and gave him daily treatments by massage, passive movements, and electricity. Under this care slight flexion of the knee was soon restored, and the atrophied quadriceps grew steadily in bulk and demonstrated a normal power to extend the leg. By September 20, the patient was walking about, able to flex the knee about 45 degrees and to extend it fully.

In October a brace was applied to the shoe to support the drop-foot, and with this the patient walked miles without fatigue.

By November 6, when the patient was exhibited before the Surgical Section of the New York Academy of Medicine, his quadriceps was fairly bulky and very strong, and responded normally to electric stimulation; he was able to flex 90°, to extend the leg fully and to hold it in extension unaided (Fig. 4), to rise normally from a crouching position (Fig. 5), and to kick vigorously.

At this writing (February 24, 1917), the drop-foot has entirely recovered; the man flexes his knee fully, extends it easily, walks up and downstairs normally; he has a fairly bulky quadriceps of very good power and a solid patella of normal contour; and he goes about his affairs without effort or fatigue.

This report is made, not to describe a method of choice, but to record the excellent result of a free muscle-tendon-bone transplantation in an unpromising case.

VERTEBRAL FRACTURE WITH LUXATION, TRANSPLANTATION OF BONE

By HERBERT P. COLE, M.D., F.A.C.S., Mobile, Alabama

THE transplantation of bone for the treatment of spinal tuberculosis is a generally accepted surgical procedure. The transplantation of bony material for spinal fracture, however, is sufficiently unique, I believe, to warrant a report of the cases.

The unusual features of a recent case of spinal fracture and dislocation required such departure from the usual methods of transplantation that they prompt me to present a report.

Among the essential principles of the transplantation procedure, as outlined by Dr. Albee, is the approximation of medullary bone to medullary bone, wherever possible. In this particular case, the vertebral dislocation caused such a distortion of the line of the spinous processes, that a transplant could not readily be fixed to the spinous processes by turning down all of the split halves on the same side; accordingly, the halves were turned down to the left in the upper portion of the spine, and to the right in the lower portion. The tibial transplant was then inserted, with its periosteal surface against the medullary surfaces of the fixed halves of the spinous processes above, and with the medullary portion of the transplant against the medullary portion of the fixed halves of the spinous processes below. It will be noted in this way that, whereas the upper portion of the transplant did not follow the rules of medullary to medullary throughout, the insert of the transplant in this manner did prevent lateral motion of the spine, and secured much better primary fixation than by the method of turning the halves down all on the same side. The final results amply justified our methods. I append the case report and the self-explanatory sketches.

J. R. V., Albany, Georgia, referred by Dr. E. K. Armistead; white, male, age 24. Past history unimportant in

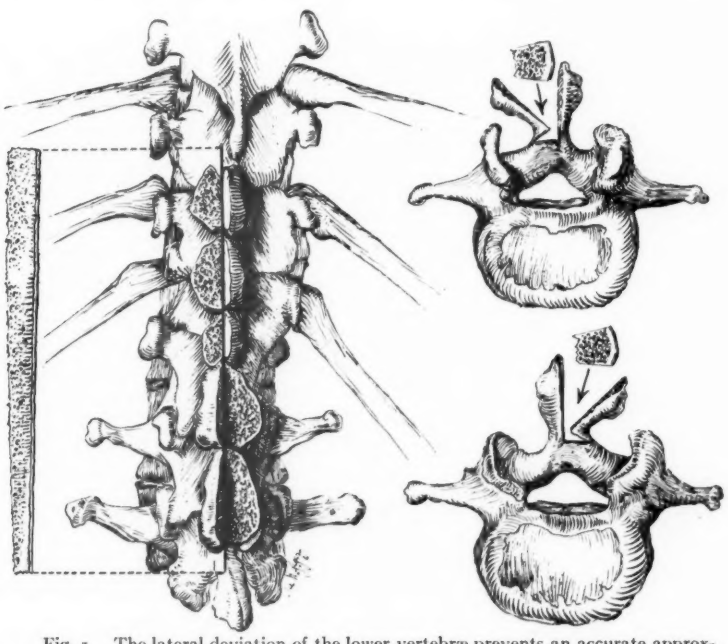


Fig. 1. The lateral deviation of the lower vertebræ prevents an accurate approximation of the transplant by the usual method of turning down the split spinous processes all on the same side. Small sketches represent the manner in which the surfaces of the transplant are presented against the fixed portions of the processes above and below. Note that such fixation of the transplant prevents lateral motion.

Fig. 2. Radiogram discloses transplant in position after operation.

relation to present illness. On March 6, 1914, the patient fell from a freight car striking on his back. About six months later, a kyphosis was noted about the middle portion of the spine. The progressively resultant pain required a plaster cast about December 20, 1915. Since December 20, up to the present time, the patient has had severe pain in the left leg and left portion of the back. At the present time, the patient is unable to walk erect and has to walk in a stooped position with his left hand on his thigh. Upon stooping, the patient complains of severe, lancinating pains to the left of the dorsal vertebræ, and excruciating pains in both lumbar regions upon sneezing or coughing.

Physical examination. A definite kyphosis at the left of the tenth dorsal vertebra. All motion painful, especially left lateral flexion and exertion. No marked motor disturbances. Clinical findings are negative. Radiogram shows a dislocation and fracture of the tenth dorsal vertebra with partial dislocation of the lower fragment to the left.

Operation. A segment of tibia about six inches in length, patterned to fit the kyphosis, was cut from the right internal surface of the tibia. The spinous processes of the tenth, eleventh, and twelfth dorsal vertebræ were split and the left halves turned downward. The spinous processes of the two upper lumbar vertebræ were split and the right side turned downward. The tibial transplant was then inserted after checking all hæmorrhage. The periosteal surface of the transplant was placed against the fixed portions of the spinous processes in the upper portion of the kyphosis and the medullary surface of the transplant lay against the medullary surface of the fixed portions of the processes below. This method prevented lateral motion of the spine.

The wound healed without complications and the bony union has evidently been all that could have been hoped for. Pain has been entirely relieved and the latitude of spinal motion is quite remarkable.

BOOK REVIEWS

A CRITIQUE OF NEW BOOKS IN GYNECOLOGY AND OBSTETRICS

By GEORGE GELLHORN, M.D., St. Louis

SOME months ago, we took pleasure in calling attention, in these pages, to two excellent books by English authors[1]: *The Sex Complex* by W. Blair Bell, and *Operative Midwifery* by J. Munro Kerr. A worthy companion to these works has just made its appearance in the *Gynæcology* by Eden and Lockyer.[2] It may not be amiss first to say a word about the authors. Both are familiar and respected figures in the gynecologic world and by numerous original contributions, have amply demonstrated their entire fitness for writing a book on gynecology. Both are obstetricians as well as gynecologists — a combination none too common in England, yet, one which, to a certain extent, guarantees a proper valuation of our special problems. Indeed, Eden is the author of a popular *Manual of Midwifery*. The intimate correlation of the indivisible sister sciences of gynecology and obstetrics, the numerous points at which they overlap can, perhaps, best be exemplified by referring to obstetric infection and its remote results, and it is this field that is more fully dealt with by the authors than is usual in gynecologic textbooks.

The subject matter is arranged along approved lines. The book is divided into three parts. Of these, the first, under the heading of General Gynecology comprises anatomy and physiology, methods of examination, prominent symptoms, disorders of development and function, and pelvic infections. Regional Gynecology forms the second part and deals with the affections of the several generative organs, while the third part contains the technique and after treatment of gynecological operations.

The authors have succeeded in keeping the instruction abreast of the most modern advances in our knowledge and in maintaining an even balance between the pathological and clinical aspects of the work. The subject of chronic endometritis is firmly based upon the fundamental researches of Hitschmann and Adler. In accordance with these authors, only the *interstitial* variety of chronic endometritis is recognized. Such an inflammatory state of the stroma may inhibit the involution which normally occurs in the uterine glands after menstruation thus rendering a physiological and transitory hyperplasia of glands pathologic and permanent.

In the removal of a malignant growth from the vulva, it is essential to extirpate the inguinal glands on both sides at the same time, whether they are palpable or not. In dealing with hæmatosalpinx and hæmatometra, a conservative radicalism is suggested. The chapter on the nature of menstruation and the rôle of the endocrine glands is written under the influence of Blair Bell whose interesting work has been alluded to in the opening sentence of this review.

As to the problems of sterility, a little more detail would seem desirable. Important contributions by American authors have not been taken into consideration; for instance, the studies by Reynolds on the chemical reaction of secretions or the sterility test by Huehner. In anterior colporrhaphy, dissection with scissors which we owe to Watkins, of Chicago, is recommended. From this advanced technique there is a lapse into antiquated and, to our feeling, faulty technique in the operation for complete tear where the authors tie their sutures in the lumen of the rectum.

But enough of details. The shortcomings are few, very few. The attractions and distinct advantages of this book are so numerous that it will easily obtain citizenship on this side of the ocean.

THE case is not quite so plain with another immigrant that seeks admission to our libraries. Jellet's book[3] has undoubtedly a good many attractive features. The theory of gynecology is well worth reading, and there are a number of discourses, for instance, on the mechanism of downward displacement of the uterus or the principles of pessary therapy, which testify to the qualifications of the author as a teacher. On the other hand, the general disposition of the book is one of unrest. For example, you may have become interested in the author's presentation of the subject of uterine cancer and would like to know his position as to therapy. You must, however, curb your impatience, for under the heading of treatment you are referred to another later page. You eagerly find the designated place, only to be told that the real treatment will be dealt with later in a separate chapter. Such interruptions disturb one's concentration and continuity of thought. This tearing apart of the discussions of the various topics occurs

[1] Surg., Gynec. & Obst., 1917, xxiv, 124 and 125.

[2] Gynæcology. For students and practitioners. By Thomas Watts Eden, M.D., F.R.C.S., F.R.C.P., and Cuthbert Lockyer, M.D., B.S., F.R.C.S., F.R.C.P. New York: The Macmillan Company, 1916.

[3] A Practice of Gynæcology. By Henry Jellet, M.D., F.R.C.P.I. Philadelphia: Lea & Febiger, 1916.

quite frequently and leads to much unnecessary repetition which merely adds to the size of the volume. How much better it would seem to economize space so as to include in the book certain subjects which have been completely omitted. The word syphilis, for instance, does not appear in the index, and in the text I have found it but once as a fleeting allusion to the etiology of elephantiasis. Are there no initial lesions about the vulva nor any condylomata lata? Why hide from the seeker-after-knowledge the fact that the vulva may be the seat of so-called soft chancres? Why devote four pages to atmocausis and zestocausis if the author himself does not use this method? Moreover, there is hardly anybody else who still employs this form of treatment.

The chapters on radiotherapy and vaccine treatment in gynecology have been contributed by two collaborators. The former contains a detailed discussion of the technical aspect of the question. The chapter on vaccine treatment makes interesting reading. The author, Dr. Rowlette, claims remarkable results with gonococcus vaccine. Complete cure of gonorrhœa seems the rule although the treatment may have to be pushed vigorously for quite a period of time. He also believes it is possible to prevent the formation of pyosalpinx by vaccination. In view of the general disappointment of this form of treatment it seems desirable to give the author's contentions a renewed and thorough test.

THE surgical aspect of our specialty has so engrossed the interest of gynecologists that the subject of sexual neuroses in the female has received but scant attention. Here and there a chapter in a gynecologic textbook or an occasional paper from the pen of a gynecologist of note form the only recent contributions to this borderland between gynecology and neurology — at least in this country. A new book on the subject by a genito-urinary specialist, is, therefore, bound to prove of value.[1] The author has made himself known to us by the sterility test which bears his name. In the present volume the chapters on masturbation in the female, nymphomania, frigidity, vaginismus, and dyspareunia are of special interest. But there are also a number of chapters on sexual neuroses in the male a knowledge of which is of decided benefit to the gynecologist. The book is written in a most fluent manner and though it disregards almost completely the demands of a literary style, it must needs impress the reader by its earnestness and directness.

THE collection of abstracts which appears every year at monthly intervals in the form of small volumes covering the entire field of medicine and surgery, has become a valued friend to the general practitioner as well as to those interested in special subjects. These booklets[2] correspond in a way to the German *Zentralblaetter*. They are not as extensive as the latter but, on the other hand, the abstracts go much more into detail and, if necessary for a better understanding, they reproduce the original pictures. The survey of the gynecologic and obstetric literature of the past year (1915) is confined mostly to American writers because the clash of arms in warring Europe has restricted peaceful scientific work for the time being. In the selection before us, the editors have again shown their discriminating judgment. Their efforts should find the hearty appreciation which they deserve.

[1] A Practical Treatise on Disorders of the Sexual Functions in the Male and Female. By Max Huchner, M.D. Philadelphia: F. A. Davis Company, 1916.

[2] The Practical Medicine Series. Series 1916, vol. iv, Gynecology. Edited by E. C. Dudley, A.M., M.D., and H. M. Stowe, M.D. Vol. vii., Obstetrics. Edited by J. B. DeLee, A. M., M. D. and H. M. Stowe, M.D. Chicago: The Year Book Publishers, 1916.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Cancer. Its Cause and Treatment. By L. Duncan Bulkley, A.M., M.D. New York: Paul B. Hoeber, 1917.

The Internal Secretions. Their Physiology and Application to Pathology. By E. Gley, M.D. Translated from the French and edited by Maurice Fishberg, M.D. New York: Paul B. Hoeber, 1917.

Localisation et Extraction des Projectiles. By L. Ombrédanne and R. Ledoux-Lebard. Paris: Masson et Cie, 1917.

Diagnosis from Ocular Symptoms. By Matthias Lanckton Foster, M.D., F.A.C.S. New York: Rebman Company, 1917.